THE CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

Vol. 3, No. 2 APRIL, 1956

JOURNAL DE LA SOCIÉTÉ CANADIENNE DES ANESTHÉSISTES

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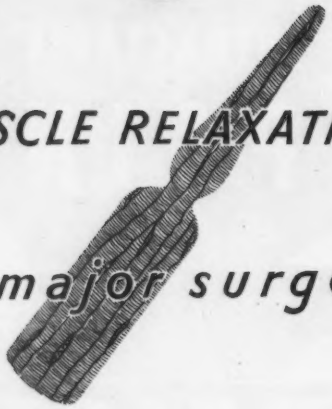

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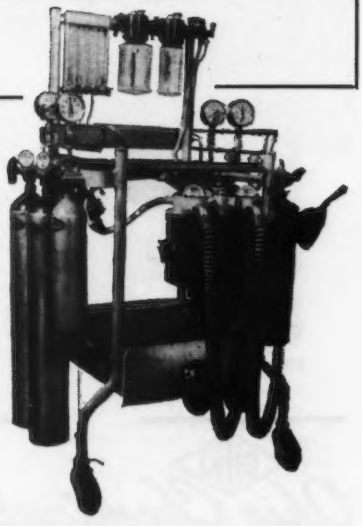

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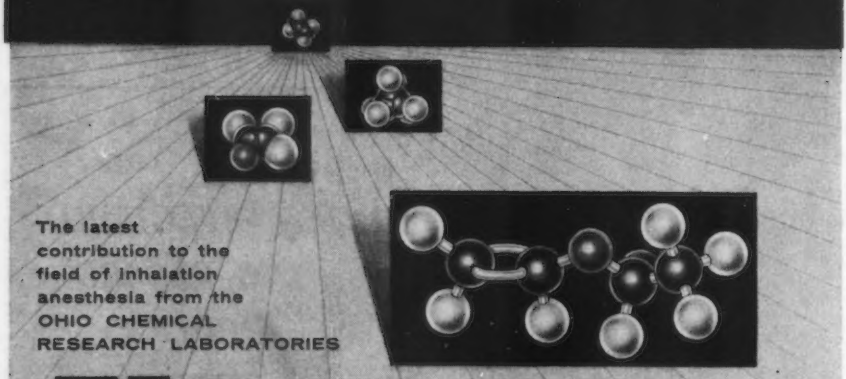

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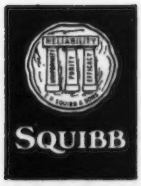

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1. Webster, C.W., C.M.A.J. Oct. 1953.

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516 Medical Arts Building, Toronto 5, Canada

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EDITORIAL

Ventilation during Anaesthesia

The realization that respiratory acidosis due to retention of carbon dioxide during the depression of respiratory activity associated with anaesthesia may lead to important disturbances of function has resulted in a laudable interest in maintaining adequate ventilation in the anaesthetized patient. We have become aware, however, that there may be a tendency for some anaesthetists to lose sight of the basic nature of the disturbance which does harm, and by being over-zealous in the elimination of carbon dioxide to produce, in fact, the very situation which they labour so hard to avoid.

It must be borne in mind that the disturbance which is damaging to the normal body functions is a shift in electrolyte balance and distribution. Such a disturbance will appear with equal readiness on the production of a relative acidosis or alkalosis. Haldane (1) showed many years ago that the body can accommodate to the presence of high concentrations of carbon dioxide in the respired atmosphere, but that *sudden* change in this concentration would produce disturbances approaching catastrophic proportions. We have known emotionally induced hyperventilation to produce tetanic convulsions and vomiting in an apparently healthy individual.

We feel that perhaps too much emphasis is being placed on the *hyperventilation* of anaesthetized patients. While it is undoubtedly true, as Dr. Cullen and his associates point out elsewhere in this Journal, that a volume of ventilation somewhat exceeding the normal is required to produce adequate exchange in these patients, we are alarmed when the production of a blood pH grossly on the alkaline side of normal is hailed as a triumph in the elimination of carbon dioxide. Let us now beware lest this become a hobby-horse which will prove as dangerous as its Trojan ancestor. We should undoubtedly be safer to think more in terms of maintaining a normal respiratory exchange in the individual patient than of trying to get rid of all possible carbon dioxide.

REFERENCE

1. Haldane, J. S., and Priestley, J. G. Respiration. Oxford: At the Clarendon Press (1935).

EDITORIAL

Ventilation durant l'anesthésie

C'est un fait que l'acidose respiratoire due à une rétention de gaz carbonique à la suite d'une diminution de l'activité respiratoire en relation avec l'anesthésie peut conduire à d'importants troubles fonctionnels; cette notion a fait naître un grand intérêt dans le maintien d'une ventilation adéquate chez le malade sous anesthésie. Toutefois, il faut être avisé: il y a tendance, chez certains anesthésistes, à perdre de vue le principe à respecter pour éviter les perturbations nuisibles; puis, en étant trop zélés pour faire éliminer le gaz carbonique, ces anesthésistes produisent, en fait, la situation qu'ils ont si laborieusement essayé d'éviter.

Il faut se rappeler que les perturbations qui deviennent nuisibles aux fonctions normales de l'organisme résident dans le déplacement des électrolytes et leur redistribution. Ces perturbations peuvent apparaître aussi promptement à l'occasion d'une acidose relative qu'à l'occasion d'une alcalose relative. Il y a quelques années, Haldane (1) a démontré que l'organisme peut supporter de hautes concentrations de gaz carbonique dans l'air inspiré, mais que le changement brusque de cette concentration peut produire des perturbations conduisant à des catastrophes. Nous avons été témoins d'une hyperventilation, engendrée par l'émotion, qui, chez un individu en bonne santé apparente, a provoqué des vomissements et des convulsions tétaniques.

Nous avons l'impression qu'on insiste trop sur l'hyperventilation des malades sous anesthésie. Sans doute il est vrai, comme l'affirmaient, quelque part dans ce journal, le Docteur Cullen et ses associés, qu'il faut faire une ventilation d'un volume dépassant légèrement la normale pour assurer des échanges adéquats chez ces malades, mais nous devenons consternés quand on nous annonce, comme un triomphe sur l'élimination du gaz carbonique, un pH sanguin fortement alcalin. Soyons bien avertis que ce cheval de bataille peut s'avérer aussi dangereux que celui de l'ancêtre Trojan. Il serait sans doute plus prudent de penser à maintenir des échanges respiratoires normaux pour un malade en particulier que d'essayer de faire éliminer le plus de gaz carbonique possible.

OBSERVATIONS OF CARBON DIOXIDE IN CONSCIOUS AND ANAESTHETIZED SUBJECTS USING THE LISTON-BECKER INFRA-RED ANALYSER

WILLIAM G. CULLEN, M.D.,* G. FREDERICK BRINDLE, M.D.,* and HAROLD R. GRIFFITH, M.D.,* F.R.C.P.(C), F.F.A.R.C.S.*

THE PHYSIOLOGICAL ROLE of carbon dioxide has long been appreciated. The gas is of paramount importance in the control of both the respiration and the circulation. *Normally* the tension of carbon dioxide in the fluids of the body is maintained within *narrow limits* (1).

However, during anaesthesia these narrow limits are certainly not always maintained. In fact, the finding of marked degrees of respiratory acidosis, owing to the build-up of excessive amounts of carbon dioxide during anaesthesia, is now commonly reported (2, 3, 4, 5, 6, 7, 8).

Although carbon dioxide is the prime factor in producing acidosis, the retention of other metabolic waste products during anaesthesia may also contribute to the clinical picture (9). Their significance requires elucidation.

Recently Bourne (10) and others (3, 7, 11), including the authors (12), have reviewed the literature on the effects of an excess of carbon dioxide during anaesthesia.

Some ten years ago the late Kenneth Heard of Toronto said that "the measure of a good anaesthetist is his ability to maintain good oxygenation in his patient" (13). If he were here with us today, I am certain that he would be the first one to modify his definition to include "the avoidance of an accumulation of carbon dioxide and other waste products."

The acquisition of a Liston-Becker infra-red analyser[1] provided us with a practical physical method of analysing the respired gas mixtures for their carbon dioxide content. Our particular sampling cell (the standard cell on Model 16) was found to be most suitable for continuous sampling of respired gases. The content of carbon dioxide of a sample of mixed gases which is passing through the cell is read on an ink-writing recorder in percentages of carbon dioxide. Thus from moment to moment, from breath to breath, from inspiration to expiration, or from even the beginning to the end of either, the actual content of carbon dioxide can be observed on the recorder. This recorder has three speeds which allow it to measure accurately the time factor (i.e., 5, 15, or 30 seconds per centimetre of paper; Fig. 1). The speed can be chosen according to the rate of respiration or the details of pattern desired in the study. Before and after each test, a calibration tracing was obtained by using as a standard a sample of carbon dioxide provided by the manufacturer; for example, 10.1 per cent carbon dioxide and 89.9 per cent oxygen. The range of the recorder was arbitrarily set

*Department of Anaesthesia, Queen Elizabeth Hospital, and McGill University, Montreal.

[1]Donated to the Department of Anaesthesia, McGill University, by Burroughs Wellcome & Co. of Canada.

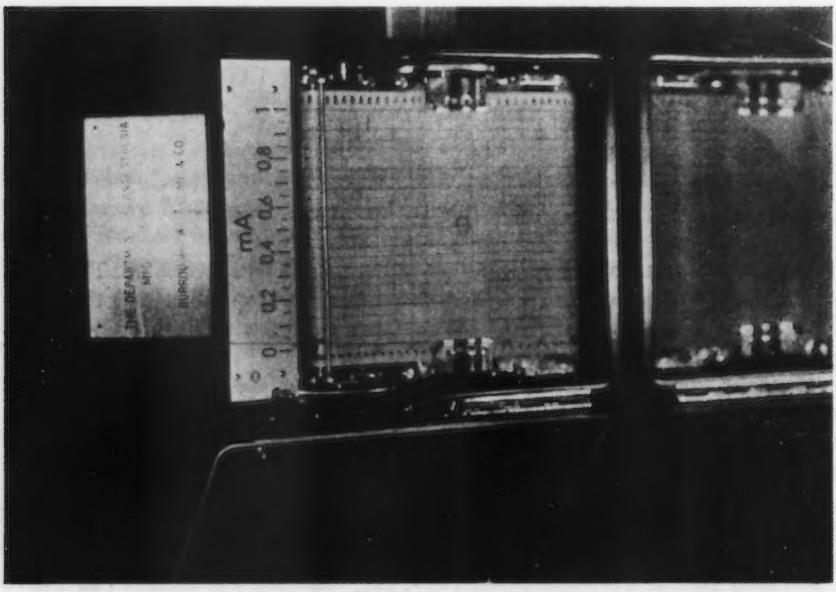

FIGURE 1. Ink-writing recorder for the Liston-Becker infra-red analyser.

from 0 to 10 per cent carbon dioxide, as we found this to be a convenient range for our observations.

We were interested to know how much carbon dioxide was present in the inspired gas, as well as the expired gas, during various (commonly accepted) anaesthetic techniques (19, 20). We had a method of monitoring not only the actual techniques but also the same technique using different gas machines. Naturally, absorption methods were first looked upon with a critical eye. Then the particular chemical used as an absorber was studied; i.e., various types of lime.

Probably the most important part of our study was related to the problem of determining the adequacy of any method of ventilation. Spontaneous ventilation (Sp. V.) was compared with manually controlled ventilation (M.C.V.) and the latter was compared with automatically controlled ventilation (A.C.V.) in so far as the content of carbon dioxide in the respired gases could serve as an index of efficiency.

Carbon dioxide accumulation is not confined to any one technique of anaesthetic administration but may occur with most, if not all, techniques (15, 18); for example, the prolonged effects of succinylcholine are probably due to carbon dioxide accumulation (16, 17).

Although most of our observations were made on anaesthetized patients, conscious volunteers were also used to obtain the carbon dioxide patterns. Only about fifty such patterns have been obtained, so that this report should only be considered as a preliminary one. However, a close study of the available tracings has proven very interesting and may challenge some of our clinical impressions.

Methods of Sampling

I. *Expiratory Only*

The Liston-Becker sampling cell is placed in the expiratory circuit of a circle absorption system just as it leaves the Y-connector at the mask or endotracheal tube (Fig. 2). The tracing provides a measurement of the carbon dioxide con-

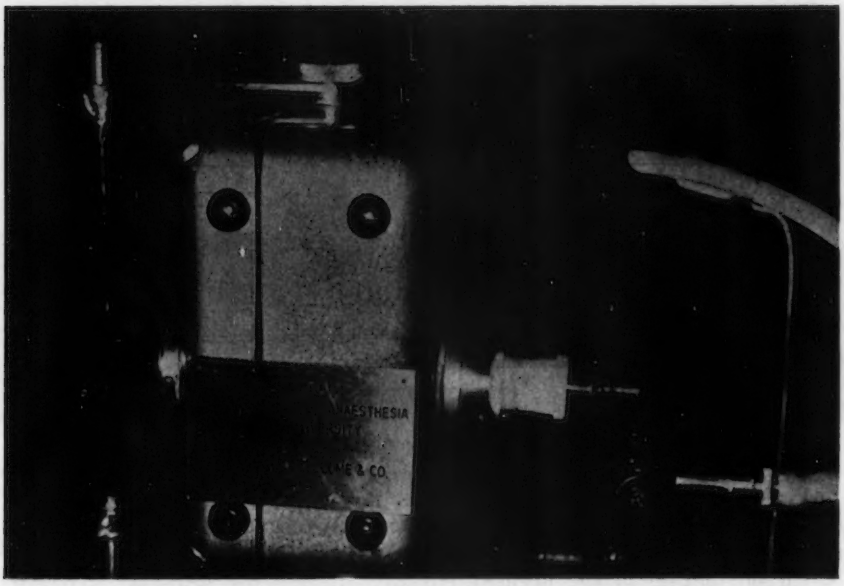

Figure 2. The Liston-Becker sampling cell placed in the expiratory circuit for expiratory sampling only.

tent of the mixed expired gases. We are particularly interested in knowing the content of the end-expiratory or end-tidal sample, as this value is as close to that of the alveolar air as can be determined. The curve rises to a plateau which is terminated by an additional short rise to a "point" immediately prior to the inspiratory phase (Fig. 3). This last "point" on the wave is thought then to represent the alveolar carbon dioxide content (14).

Initially we thought that this method of sampling would be the most accurate way to determine the carbon dioxide content of the end-expiratory sample. However, it seemed that the fresh gases, if entering at a high flow rate, could readily pass through the Y-connector and contaminate the sample in the cell. In addition, if inspiration were assisted or controlled a greater spill-over into the expiratory arm would occur from the inspiratory side. Although such contamination of the sample could readily occur with anaesthetized subjects, it was also possible in conscious ones, even though to a lesser degree.

II. *Inspiratory Only*

The Liston-Becker sampling cell is placed in the inspiratory circuit at the inspiratory valve of the machine. It can also be placed next to the "Hico"

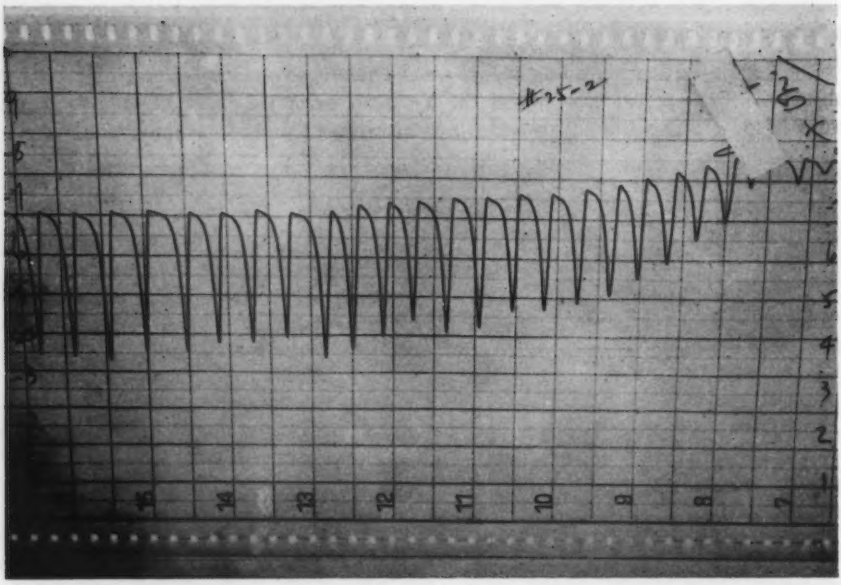

FIGURE 3 (Tracing no. 25–2). Tracing obtained during expiratory sampling, showing alveolar carbon dioxide values between 6.7 and 7.5 per cent at the upper limits of the pattern.

detector[2] when the latter is adjacent to the inspiratory valve. This detector is a simple device introduced by Draper (21) which determines the concentration of carbon dioxide in the inspired mixture, utilizing the acid-base indicator, bromcresol purple.

Tracing no. 6 (Fig. 4) shows the inspiratory pattern obtained with a conscious subject when the degree of absorption of the machine was deliberately changed. The levels of carbon dioxide at which the "Hico" detector changed in colour were recorded.

Indicator Colour		*Carbon Dioxide Content*
Deep purple – Faded 0		0.1 – 0.2 %
Deep purple – Faded 0		1.8 – 2.0 %
Purple – Very slightly faded	+	3.5 – 3.7 %
Purple – Definitely faded	+ +	4.2 – 4.4 %
Clear colour – Faded	+ + +	5.6 – 6.0 %
Straw colour – Faded	+ + + +	8.4 – 9.0 %

Thus it can be seen that a carbon dioxide level of over 3.5 per cent was necessary to produce even slight fading in this indicator and at least 4.0 per cent was needed to produce a change in colour readily recognized by several observers. Although the efficiency of the "Hico" detector may, at first, not seem adequate, we have clinically found the device to be a helpful indicator of rising carbon dioxide in the inspiratory circuit. At levels of carbon dioxide producing colour

[2]Available from the Ohio Chemical Co. of Canada.

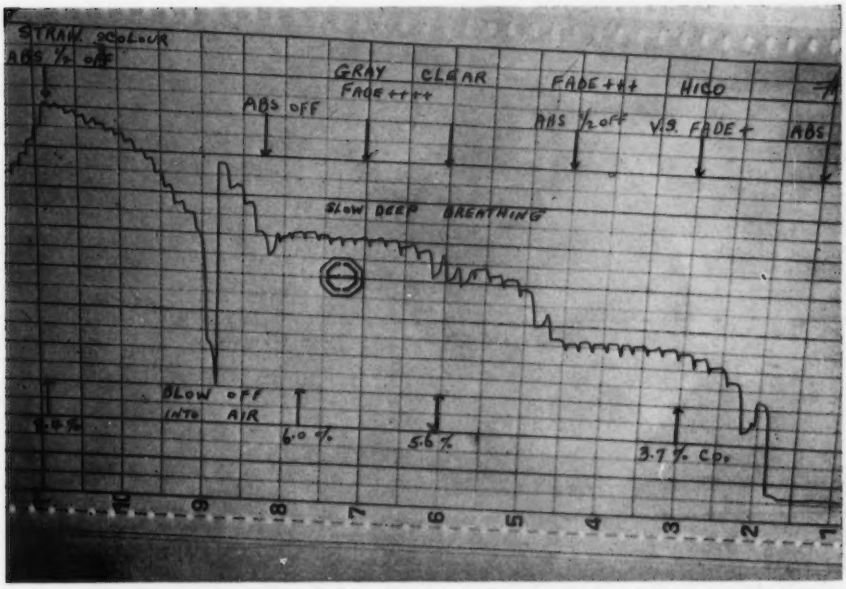

FIGURE 4 (Tracing no. 6–1). Inspiratory pattern showing the carbon dioxide values in percentages corresponding to changes in colour of the "Hico" detector. "Abs" means absorber. Tracing starts at the right with the absorber turned one-third off.

change in this indicator, there may still be very little other clinical evidence of carbon dioxide accumulation. On the other hand, when this indicator dye does fade, we should realize that the levels of carbon dioxide have already risen considerably.

Recently the British Oxygen Company have introduced a somewhat similar chemical carbon dioxide analyser, but we have not had an opportunity to monitor its efficiency.

III. *Tidal: Inspiratory and Expiratory*

During these studies we have found tidal sampling to be the most practical as it presented fewer difficulties, and moreover, the most interesting and helpful patterns.

For tidal sampling, the Liston-Becker sampling cell is connected directly to the mask or the endotracheal tube, thus allowing *all* the respired gases to pass through the analyser (Fig. 5). A comparison between the inspiratory and expiratory levels of carbon dioxide is always available. Consequently, most of our tracings are those obtained by tidal sampling.

TECHNIQUES WITH CARBON DIOXIDE ABSORPTION

I. *Gas Machines*

The efficiency of carbon dioxide absorption by some type of lime in a gas machine was evaluated in both *conscious* and *anaesthetized* subjects. Nine indi-

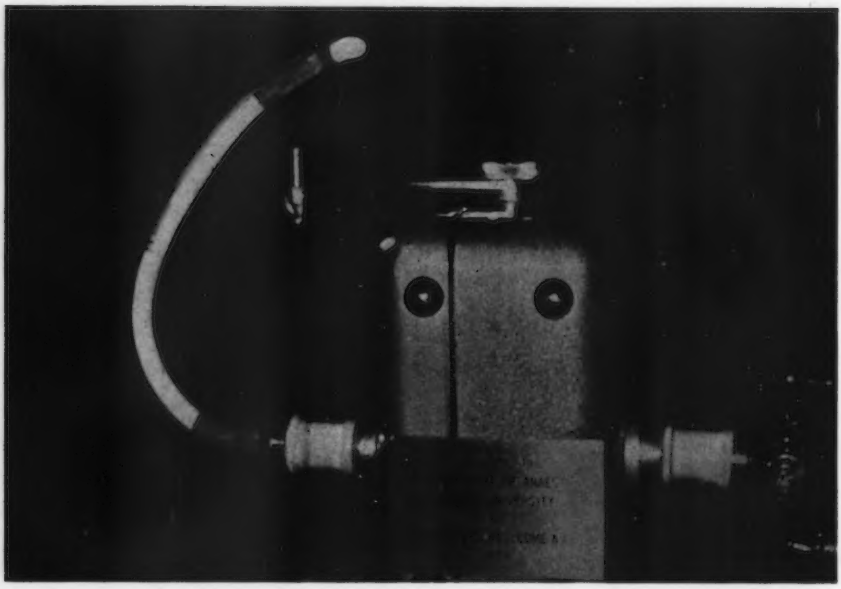

FIGURE 5. The Liston-Becker sampling cell placed in the circuit for tidal sampling of inspiratory and expiratory gases.

vidual machines of various manufacturers were studied using the same brand of lime in each (Heidbrink, Foregger (circle and to-and-fro types), Boyle, Loos, Marrett, and Reserve Midget).

We were initially intrigued by the rapidity with which the pattern would change when the absorber was turned off, and again when it was turned on. With the very next breath of the subject, after absorption was stopped, the inspiratory carbon dioxide level sharply rose and continued to rise with each succeeding breath. At the same time, the expiratory level very gradually rose, with the result that the two levels soon approached each other. The tracing was then only a shallow wavy line at a level of about 9–10 per cent, in the conscious cases.

It was an interesting finding that none of the conscious volunteers would tolerate over 10 per cent carbon dioxide. One subject, on several tests, signalled to have the absorber turned on only when the recorder indicated exactly 10 per cent carbon dioxide (24). When the absorber was turned on, the levels rapidly returned to normal (Fig. 6).

Harbord found "alveolar" carbon dioxide levels above 7 per cent in a high proportion of patients, after making over 300 observations (22, 23).

We were surprised to find the "alveolar" levels in several of our volunteers, when breathing either air or oxygen, to be between 7.0 and 8.0 per cent (Fig. 7). There is probably a considerable variation in subjects.

Thus there is very good evidence of the efficiency of this method of carbon dioxide control. In general, all the common machines used by anaesthetists (at

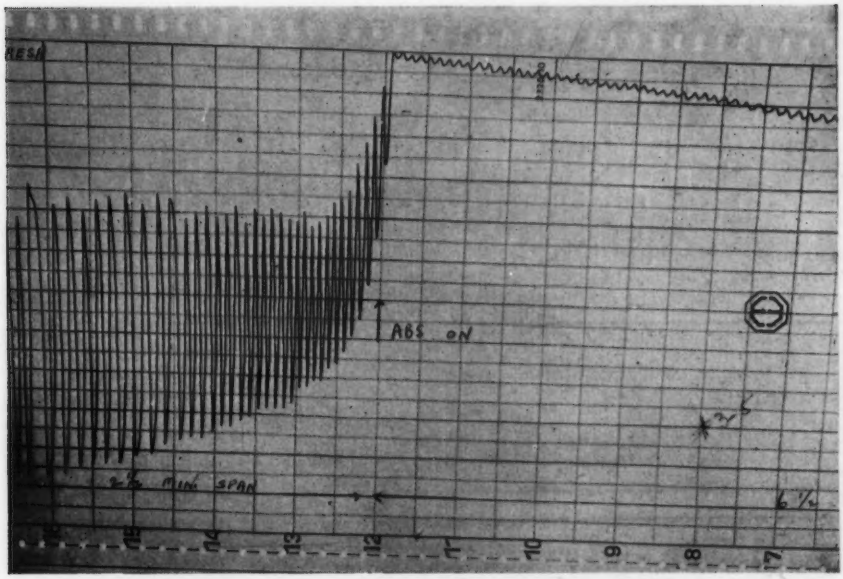

FIGURE 6 (Tracing no. 3–5). Carbon dioxide tracing of conscious volunteer with absorber off until the pattern reached the peak which represents 10 per cent carbon dioxide. The lower points of the pattern represent inspiratory levels and the upper points represent expiratory levels of carbon dioxide.

least the particular ones tested) have quite efficient absorption units. However, when a single test pattern was obtained from several machines, changing every minute or two from one to another, quite a variation was obtained. When monitoring absorption efficiency in this way, the inspiratory carbon dioxide levels were most significant. Although most of the patterns were obtained with the subjects breathing oxygen with or without anaesthetic gases, we did obtain a few tracings (not illustrated) when conscious subjects inspired predetermined concentrations of carbon dioxide.

Although most of the absorption units provided consistently comparable patterns indicating efficiency, two units repeatedly provided tracings indicative of a higher degree of efficiency. One machine indicated by F in the tracings produced an inspiratory pattern indistinguishable from that of room air, or from that obtained with a non-rebreathing valve (Fig. 7).

On the other hand, one unit persisted in producing a definitely higher inspiratory level of carbon dioxide, but it also gave the conscious patient definite evidence of resistance during inspiration and expiration (Figs. 7 and 8). Further trials with other specimens of this "brand" of machine should be done.

II. *Absorption Lime*

Three different "brands" of lime, provided for anaesthetic machines, were used in these tests. The tracings indicated that each specimen of fresh lime proved to be a good absorber of carbon dioxide when initially used.

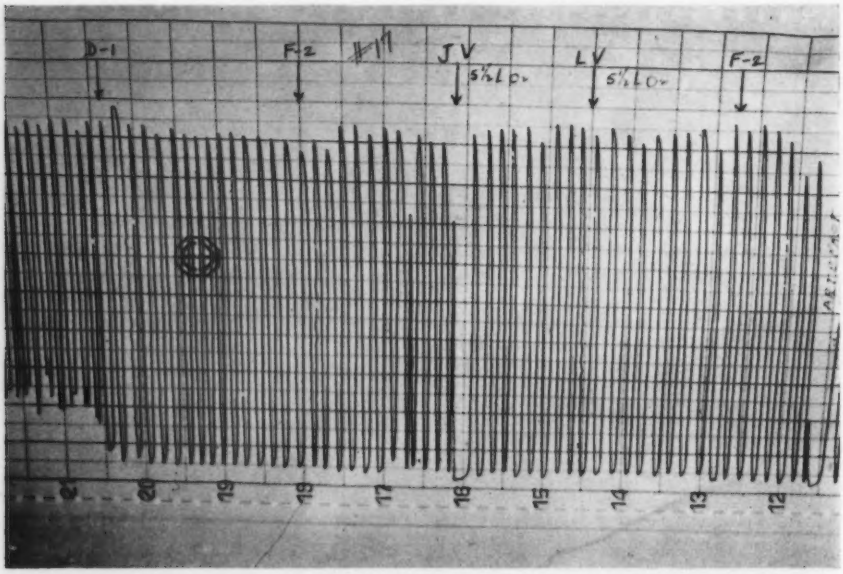

FIGURE 7 (Tracing no. 17). Carbon dioxide pattern of conscious volunteer, changing frequently from one gas machine to another. F–2, one machine with closed circle system with absorption; D–1, another machine with closed to and fro system with absorption; JV, one machine with non-rebreathing valve; LV, another machine with non-rebreathing valve. All, except D–1, produced very good inspiratory levels of carbon dioxide.

It has been reported by Gibbon *et al.* that lime required frequent changing (every 20–30 minutes) when ventilation was automatically controlled, because of the increase in minute volume. Our short experience with automatically controlled ventilation in this study seemed to bear out this requirement. However, the efficiency of one brand of lime seemed to decline after 2 or 3 minutes with the inspiratory levels, slowly creeping up thereafter. Another brand maintained its efficiency at the initially good level after at least 45 minutes of automatically controlled ventilation (Fig. 9). Thus there may be some variation in the efficiency of lime. We have, as yet, no observations on the efficiency of various limes after prolonged periods of use or after periods of rest. Very wet lime was found to be less efficient than the standard product (Fig. 10).

TECHNIQUES WITHOUT CARBON DIOXIDE ABSORPTION

In England there has been for many years, and in Canada more recently, a technique with no absorption of carbon dioxide but rather an intentional partial rebreathing. It is usually referred to as a semi-closed to-and-fro method. It should not be confused with the to-and-fro Water's absorption unit which can also be used in a semi-closed circuit.

This English inhaler consists of a mask, expiratory valve, single breathing tube, and a small bag attached to the machine.

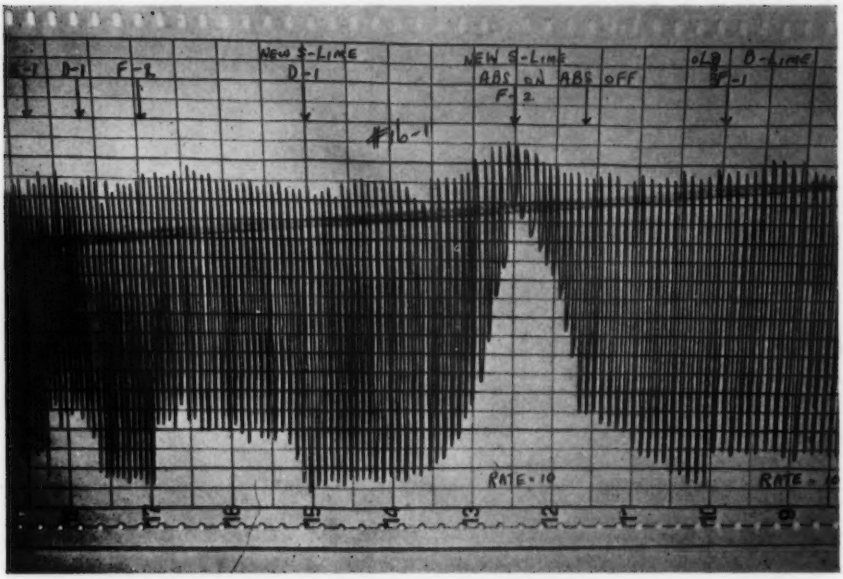

FIGURE 8 (Tracing no. 16–1). Carbon dioxide pattern of conscious volunteer with absorption using various limes and various machines and a slow recorder. The lower points of the pattern (inspiratory levels) change with the efficiency of the lime or the machine. As the absorber is on or off the level changes with each breath. Rate of respiration was 10 (as indicated).

It is a very practical unit for the administration of nitrous oxide, oxygen and ether, or trichlorethylene.

In 1946 A. Charles King repeats (25) that "rebreathing is not only economical but physiologically sound in that it prevents the patient suffering from carbon dioxide deficiency." Our tracings, with all methods, indicate that there is never any need of being concerned about carbon dioxide *deficiency* but rather about an excess.

Some carbon dioxide patterns were obtained in the conscious patient with oxygen, as well as in the anaesthetized patient with nitrous oxide and oxygen, with or without trichlorethylene (T.C.E.). The Liston-Becker cell was placed at the mask between the latter and the expiratory valve. One tracing was obtained from a patient having sigmoidoscopy under pentothal–N_2O–O_2–T.C.E. anaesthesia with the above technique, using a five-litre bag. The total gas flow was varied from 0.5 litres to 15.0 litres on the machine unit designated J. After a pentothal induction (300 mg.), a mixture of 6 litres N_2O plus 2 litres O_2 was started with a small amount of T.C.E. When the total flow was at least 8 litres, quite a good pattern was obtained. However, when it was increased to 9, 10, 11, 13, 14, and 15 litres, no appreciable improvement occurred. But when the total flow was decreased to 7, 6, 5, 4, 2, 1 and ½ litres, a very definite upward shift in the inspiratory levels occurred at every step, especially below 6 litres.

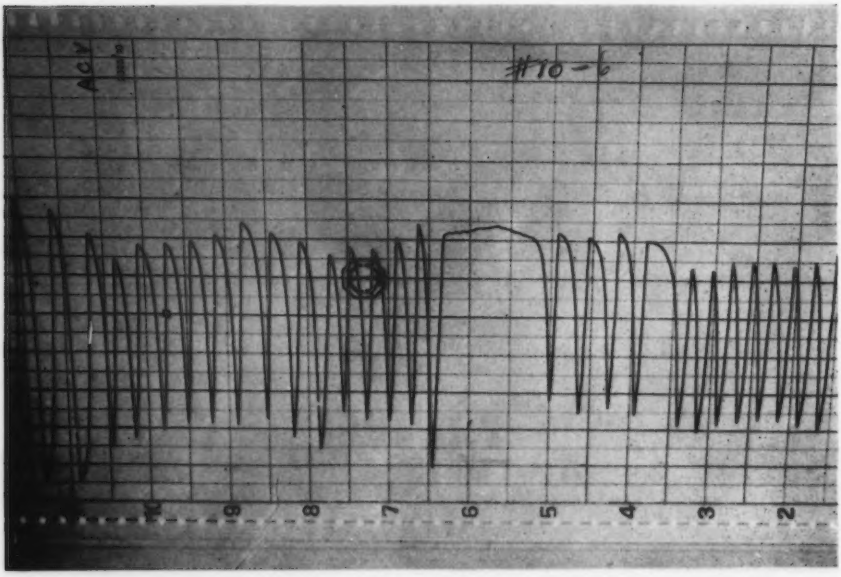

FIGURE 9 (Tracing no. 10–6). Pattern in anaesthetized subject comparing M.C.V. (manually controlled ventilation) with A.C.V. (automatically controlled ventilation on Jefferson ventilator); M.C.V. in various degrees of pressure and rhythm from no. 2 to 10½ on tracing. Note the better pattern after A.C.V. is started. Lime used over 45 minutes.

This tracing (not illustrated) is complicated by an increase in respiratory rate unrelated to raised carbon dioxide levels but rather due to T.C.E. This rapid shallow respiration can be shown to be very inefficient when considering carbon dioxide elimination.

Fig. 11 shows the effects of this method when using only oxygen, in a conscious volunteer. The conscious experienced subject soon objects to the expiratory resistance in the circuit. He is forced to expire against positive pressure a good deal of the time because of the high inflow of gases and the resistance in the expiratory valve. If the bag is suddenly emptied he will quietly and comfortably breathe directly to and from the bag. The tracing will immediately show a sharp rise in carbon dioxide levels and as the pressure builds up, the subject will eventually blow open the expiratory valve with an inner sense of great relief; this is only to be followed soon by another build-up of pressure and carbon dioxide.

If a non-rebreathing valve is used in place of the expiratory valve in such a circuit, the expiratory resistance is immediately removed and the carbon dioxide pattern simulates that obtained with the Liston-Becker cell open to room air (Fig. 7).

VENTILATORY EFFECTS ON CARBON DIOXIDE LEVELS

Since it has been shown (24) that ventilation bears a very direct relationship to the alveolar and arterial levels of carbon dioxide, we cannot stress too

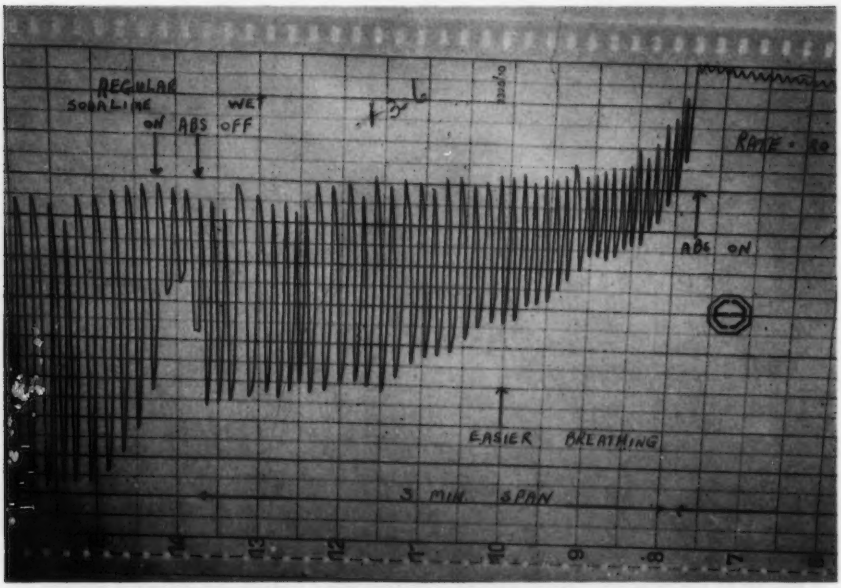

FIGURE 10 (Tracing no. 3–6). Pattern in conscious volunteer, to be compared with Fig. 6. At the right the tolerance level of 10 per cent carbon dioxide is reached, while respiratory rate is only 20 per minute. Very wet lime does not return inspiratory levels to normal in a comparable span of time, whereas regular lime is effective.

emphatically the need for adequate ventilation. In clinical anaesthesia, whether you are watching the movements of the chest and abdomen, or feeling the rate, regularity, and force of expiration on the palm of your hand, or seeing or feeling the movements of the breathing bag, how can you judge the adequacy of the ventilation? Do you satisfy yourself by the colour of the skin or blood? Do you compare the ventilation of your anaesthetized patient with that of the same patient you may have observed sleeping in bed on the previous evening? If so, is the extent of the ventilation during sleep adequate for the same patient when anaesthetized? There is no useful clinical evidence of carbon dioxide retention.

It has been known for some time that the total ventilatory minute volume necessary for the prevention of respiratory acidosis in the anaesthetized patient is in excess of that required by the normal unanaesthetized individual. A value two or three times the resting normal values may be required to maintain a normal arterial carbon dioxide tension (15).

Thus we were keenly interested to see the effects on the carbon dioxide tracing of clinically adequate spontaneous ventilation, manually controlled ventilation, and automatically controlled ventilation. The latter was obtained with the Jefferson Ventilator (Fig. 9).

These tracings show very clearly that the automatically controlled ventilation proved consistently uniform inspiratory and expiratory levels, for example, 0.5 per cent and 6.0 per cent respectively. Each time the ventilation was

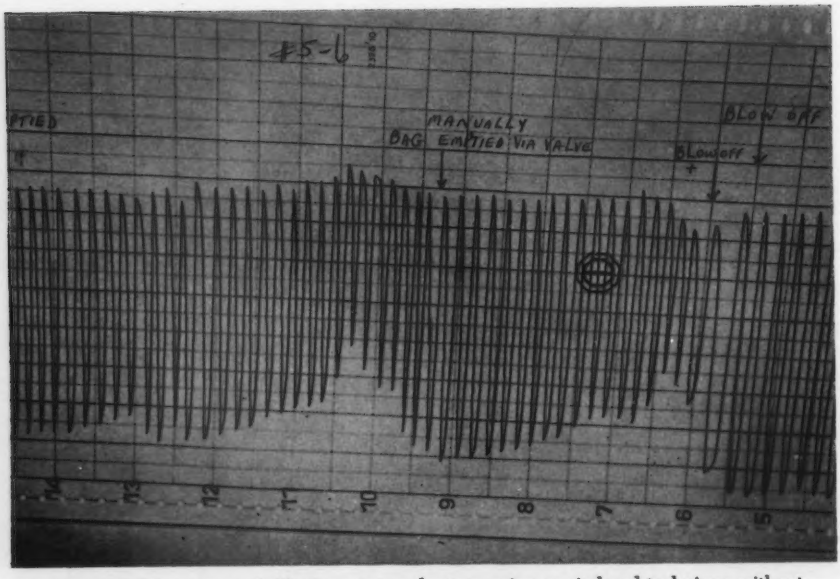

FIGURE 11 (Tracing no. 5–6). Conscious volunteer, using semi-closed technique without absorption, breathing oxygen.

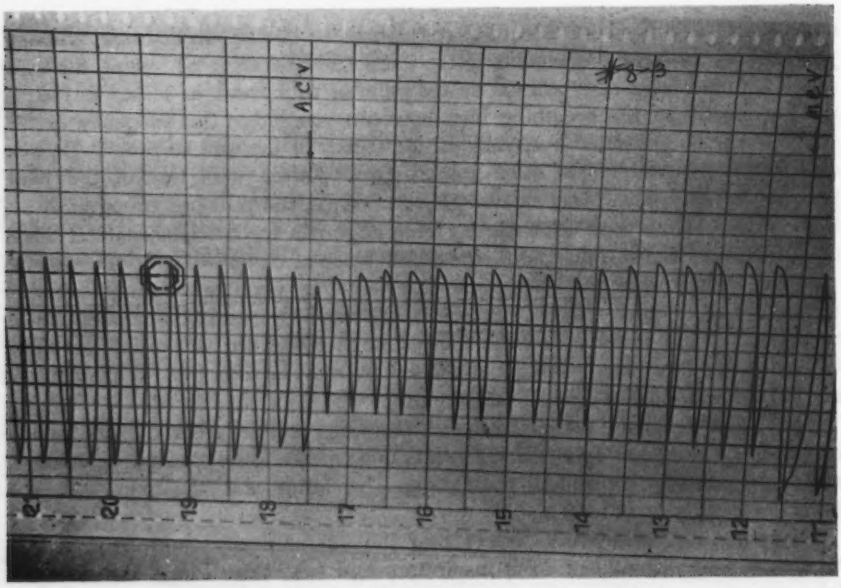

FIGURE 12 (Tracing no. 8–3). Anaesthetized subject showing the lower inspiratory levels when A.C.V. is compared with M.C.V., reading from right to left.

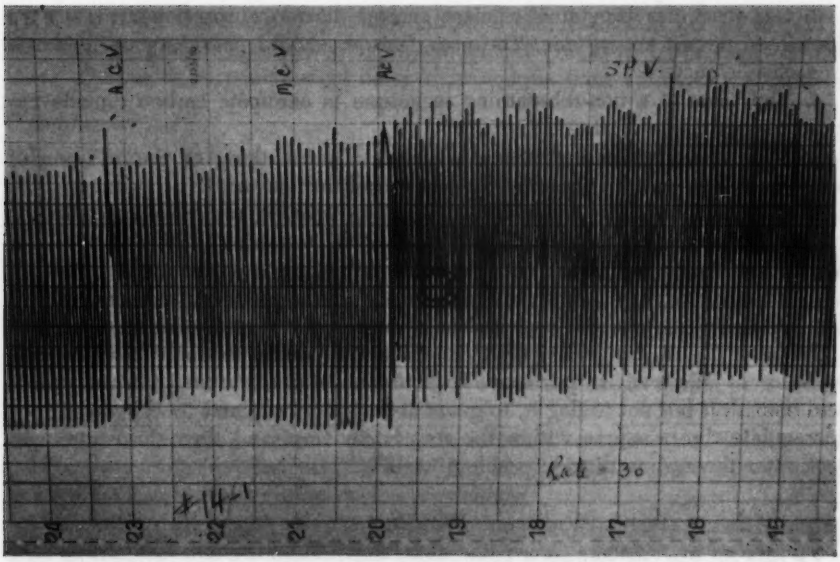

FIGURE 13 (Tracing no. 14–1). Anaesthetized subject showing effects of various types of ventilation, reading from right to left. Respiratory rate is 30 per minute during spontaneous ventilation while A.C.V. rate is 24.

switched over to manual control, the efficiency depreciated very definitely, in spite of the most clinically efficient manner in which any of us could perform the method. Possibly we are not gifted with "educated hands." Thus we were soon convinced of the superior results obtained with the automatic ventilator. No doubt the effects on the circulation are equally superior, especially when the positive and negative pressures are suitably adjusted to the particular patient (5) (Fig. 12).

Expiratory levels during spontaneous ventilation appear much higher than those obtained by automatically or manually controlled ventilation (Fig. 13). Does this mean that this particular subject is better able to eliminate carbon dioxide from his alveoli by spontaneous ventilation than we are able to do for him by manual or mechanical means? We cannot answer this problem but it leaves a challenging observation with us.

CONCLUSIONS

1. Carbon dioxide levels in the inspired gas mixture can rise very suddenly and persistently. What is more dangerous and more common is the unsuspected chronic accumulation of carbon dioxide which may develop insidiously. This will jeopardize the ability of the patient to eliminate carbon dioxide (1), especially when he is already depressed by anaesthetic drugs. Gray reminds us that in the anaesthetized subject concentrations of carbon dioxide as low as 5 per cent may lose their stimulatory effect and be converted to a depressing one (24).

2. The need for some simple device for detecting carbon dioxide during anaesthetics should be emphasized.

3. Gas machines providing efficient carbon dioxide absorption are essential for closed circuit anaesthesia. The manufacturer should provide good evidence of such efficiency.

4. The value of a non-rebreathing technique to eliminate carbon dioxide has been clearly shown (26, 27, 28, 29).

5. Anaesthetic techniques which involve any rebreathing or the addition of carbon dioxide should be critically challenged.

6. Effective alveolar ventilation, in addition to oxygenation, should be the insistent objective of every anaesthetist. Should we adopt the motto "V for Ventilation"?

7. Further studies of carbon dioxide levels in the respired gases, as well as in the arterial system, are essential to the progress of anaesthesia.

Professor W. R. Spurrell recently concluded a discussion of carbon dioxide as follows: "We want to put more faith in the respiratory centre, to cherish it and nourish it but not to flog it, to guard its blood supply and its oxygen supply, to regulate the pressures within the respiratory tract and then the centre will look after the carbon dioxide problem itself" (23).

Résumé

Le rôle du gaz carbonique a longuement été discuté. Le gaz carbonique joue un rôle de premier ordre dans le contrôle de la respiration aussi bien que dans celui de la circulation. Chez l'individu normal, la tension du gaz carbonique dans les liquides de l'organisme ne présente que de légères variantes (1).

Toutefois, au cours de l'anesthésie, il peut arriver que les limites normales soient dépassées. En fait, on rapporte couramment de nos jours des cas d'acidose respiratoire marquée, due à l'accumulation, au cours de l'anesthésie, de grandes quantités de gaz carbonique (2, 3, 4, 5, 6, 7, 8).

Bien que le gaz carbonique soit le principal facteur dans la production de l'acidose, la retention, au cours de l'anesthésie, de certains autres produits du métabolisme peut aussi contribuer à réaliser ce tableau clinique (9). Mettons en lumière l'importance de leur rôle.

L'appareil Liston-Becker, analyseur à infra-rouge, nous a permis d'analyser, par une méthode physique pratique, les atmosphères respirées et de connaître leur contenu en gaz carbonique.

Ainsi nous avons pu observer à tous les instants, à toutes les respirations, à l'inspiration et à l'expiration, le pourcentage de gaz carbonique présent.

Nous étions intéressés à connaître le pourcentage de gaz carbonique dans l'air inspiré aussi bien que dans l'air expiré au cours des différentes techniques anesthésiques en usage courant (19, 20).

Notre méthode ne nous a pas permis seulement d'évaluer les techniques actuelles mais également d'évaluer les différentes machines à anesthésie. Naturellement, nous avons commencé par les méthodes d'absorption dans un but critique. Après, nous avons étudié les différentes substances employées pour absorber le gaz carbonique, c'est-à-dire la variété des sortes de chaux.

La plus grande partie de cette étude, probablement, est consacrée à l'évaluation de l'efficacité de chacune des méthodes de ventilation. Nous avons comparé la

ventilation spontanée (Sp. V.) à la ventilation contrôlée à la main (M.C.V.), celle-ci à la ventilation contrôlée automatiquement (A.C.V.), en prenant comme index d'efficacité, le pourcentage de gaz carbonique dans l'atmosphère expirée.

Conclusions

1. Le taux de gaz carbonique dans les mélanges de gaz inspirés peut s'élever rapidement et de façon continuelle. Ce qu'il y a de plus dangereux et de plus fréquent, c'est l'accumulation chronique et insoupçonnée du gaz carbonique qui peut survenir insidieusement. Elle peut compromettre, pour le malade, la possibilité d'éliminer son gaz carbonique (1), surtout s'il est déprimé par les agents anesthésiques. Gray nous rappelle que, chez des sujets anesthésiés, des concentrations de gaz carbonique aussi basses que 5 pour-cent peuvent perdre leurs effets stimulants et acquérir des effets dépresseurs (24).

2. Il faudrait insister sur la nécessité de trouver un procédé simple pour doser le gaz carbonique au cours des anesthésies.

3. Pour faire de l'anesthésie en circuit fermé, il est essentiel d'avoir des machines assurant une absorption efficace. Les manufacturiers devraient pouvoir prouver l'efficacité d'absorption de leurs machines.

4. La valeur de la technique de non-réinspiration pour éliminer le gaz carbonique a été clairement démontrée (26, 27, 28, 29).

5. Il faut se défier des techniques d'anesthésie où il existe une certaine réinspiration, ou encore, où il y a une addition de gaz carbonique.

6. En plus de l'oxygénation, la ventilation alvéolaire efficace devrait être l'objectif constant de tous les anesthésistes. Ne devrions-nous pas adopter le motto "V pour Ventilation"?

7. Il est essentiel, pour le progrès de l'anesthésie, que soit poursuivie l'étude des taux de gaz carbonique dans l'air inspiré aussi bien que dans le sang artériel.

Récemment, à la suite d'une discussion sur le gaz carbonique, le Professeur W. R. Spurrell concluait ainsi: "Nous voulons augmenter notre confiance dans le centre respiratoire, nous voulons en prendre soin et le nourrir et non pas le fouetter, nous voulons lui conserver ses réserves de sang et d'oxygène, nous voulons régler les pressions dans les voies respiratoires et, alors, le centre respiratoire s'occupera lui-même du problème du gaz carbonique" (23).

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BARBITURATES IN OBSTETRICS: EFFECTS ON THE NEWBORN*

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THE BARBITURATES are employed in obstetrics with the objective of rendering the patient quiet and drowsy so that she will sleep between pains and not remember the ordeal but nevertheless remain sufficiently conscious to assist in the delivery. Their disadvantages, especially when administered intravenously or by the rectal route, have been emphasized frequently and one would think that there is little need for reiteration. However, some obstetricians still administer large doses of barbiturates to obtain basal anaesthesia and analgesia.

We practise in one part of this country where barbiturates are still widely used in obstetrics, both by intravenous and rectal administration. The Department of Anaesthesiology was aware of the physiological changes these drugs could produce on the newborn. To satisfy our curiosity, we first made no efforts to modify the procedure already established, and, second, recorded statistical data concerning the effects on the newborn.

All the cases included in this series were followed by a member of our anaesthesia staff. All the patients anaesthetized by nurses or interns were excluded. We also excluded the pathological cases in which the condition of the newborn was possibly due to the obstetrical trauma. The cases in this series totaled 2605, which, when classified under the type of drug combination used to produce analgesia, give the following figures.

Demerol and hyoscine—1040 cases
Demerol, hyoscine and an oral barbiturate—562 cases
Demerol, hyoscine and rectal Pentothal—561 cases
(Average dose of Pentothal 1.5 grammes)

Barbiturates were also used intravenously in 133 cases (mostly for Caesarian section). Somnifine or barbituric diethyl acid isopropyl, barbituric acid diethylamine was used in 55 cases intravenously during labour.

General anaesthesia was given in 90 per cent of the cases, consisting of N_2O+O_2 or $C_3H_6+O^2$. Spinal anaesthesia and caudal block accounted for the other 10 per cent of the cases.

For statistical purposes, we have considered three types of conditions in the newborn:

1. A breathing time of 1 minute or less.
2. A breathing time of between 1 to 5 minutes with the help of reanimation measures.

*Presented at the Annual Meeting of the Canadian Anaesthetists' Society, Toronto, June 20, 21 and 22, 1955.

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3. A breathing time of more than 5 minutes with all possible resuscitative measures.

Reanimation consisted first of aspirating the secretions from the upper respiratory tract, after which a mechanical resuscitator was used, associated with endotracheal intubation when it was necessary. It was also routine to empty the newborn's stomach.

Among the various types of drug combinations used to produce analgesia, association no. 1 (Demerol 100 mg. and hyoscine gr 1/150) has seemed to influence the breathing time to a less degree than the others. It is usually said that with Demerol and hyoscine untoward effects on the mother and the child are absent. Nevertheless we have found that reanimation was necessary in 14 per cent of the cases. The effect on the newborn was greater when this combination was repeated every two or three hours or when a single dose was given within one hour of the delivery. In one case a syncopal reaction occurred in a patient, with sweating, hypotension, and bradycardia shortly after an injection of meperidine. The mother gave birth to a dead baby 45 minutes after this syncopal reaction. In our opinion the newborn's condition was secondary to the pronounced fall in the mother's blood pressure.

Combination no. 2 consisted of Demerol 100 mg. and hyoscine gr. 1/150 and a barbiturate, usually secobarbital (Seconal) or pentobarbital sodium (Nembutal), given by mouth. The usual dosage for the barbiturate was 1½ grain. The barbiturate was seldom given within two hours of expected delivery. Most people consider barbiturates given orally a satisfactory method of obtaining good amnesia and safe analgesia. Nevertheless the percentage of reanimation, which was less than 15 per cent when Demerol and hyoscine alone were used, increased to 25 per cent with the addition of a barbiturate. This, I think, has a great significance and also a great importance, because short-acting barbiturates are frequently employed in various combinations with other agents, particularly with Demerol and hyoscine.

Combination no. 3 consisted of Demerol and hyoscine in the usual proportion, given subcutaneously, and a short-acting barbiturate, usually Pentothal, given by the rectal route. The Pentothal was given in a dose of 1½ gram, in a 2½ per cent solution, and was seldom given within two hours of expected delivery. This association of Demerol, hyoscine, and rectal Pentothal has procured almost complete amnesia to the mothers, and a very light anaesthesia needed to be added for the delivery. However it was found to be the most disastrous for the child. More than 35 per cent of the newborns needed reanimation. In many instances the reanimation was long and laborious, requiring sometimes five minutes and more.

In three instances when the barbiturates had been given within two hours of the delivery the normal-term babies were dead at birth. The post-mortem on each failed to reveal any abnormality or obstetrical trauma. It was believed that the barbiturate should most likely be blamed.

Intravenous injection of barbiturates (specially Pentothal) was used 140 times, mostly for Caesarian sections. The dose never exceeded 250 mg. followed by N_2O+O_2 and a relaxing agent. An average of five minutes elapsed between

the injection of the barbiturate and the clamping of the cord. Premedication for Caesarian section consisted of atropine only. The percentage of asphyxiated babies was similar to the one observed when the barbiturate was given by the rectal route, with the exception that the asphyxia was not quite as severe. Not a single newborn was lost. Such a result is due in part to the fact that a small amount of Pentothal is injected not more than five minutes before the clamping of the cord and it is due also to the absence of obstetrical trauma.

Another barbiturate called "Somnifene" (diethyl barbituric acid) was given 55 times intravenously during labour. Its effect in prolonging the breathing time was striking, the reanimation rate being over 40 per cent; the reanimation was difficult in most of these cases. One of these babies was very cyanotic and in spite of adequate resuscitation he died six hours later. There had been no obstetrical trauma and the post-mortem revealed no malformation of any kind. It was believed that the hypoxia began *in utero* as in the previous cases, the mother's depressed respiration creating a state of hypoxia which secondarily affected her child. The harmful effects of these drugs was most evident when a potent anaesthetic like cyclopropane was used. There were fewer depressed babies when nitrous oxide or spinal was used.

The incidence of reanimation was greater among primipares than among multipares, and this is surely related to the longer duration of the primipare's labour, with concomitant use of larger amounts of depressing drugs.

N–Allinormorphine or Nalline was used 35 times both for patients who received Demerol and hyoscine and for those who received Demerol and hyoscine and Pentothal. It has seemed to aggravate the respiratory depression in those already touched by the barbiturates. The number of cases in which it was used is not great enough to allow definite conclusions to be drawn.

One need not be surprised by the deleterious effects of the barbiturates on the foetus when one considers the mode of action, and the facility with which barbiturates cross the placental barrier. Not only the respiration in the newborn is retarded by all central depressants given to the mother but the respiratory mechanism of the mother may also be affected adversely by the use of barbiturates, with consequent foetal hypoxia.

Adequate resuscitative measures account for the mortality rate not being greater than it has been, but even then some stillbirths of normal-term babies cannot be understood except by the theory of foetal hypoxia. Even with good resuscitative measures the foetal mortality rate was above what is considered the normal in our days.

Curare

During these last four years we have employed decamethonium bromide in many obstetrical cases, both to provide adequate muscular relaxation and to allow smaller amounts of anaesthetics to be given. Decamethonium bromide was used 354 times for vaginal deliveries. The patient is usually anaesthetized with cyclopropane and between 2 and 3 mgm. of Syncurine are injected before the forceps are applied.

For Caesarian section anaesthesia is induced with Pentothal (usually 200 mg.),

the induction being delayed until the obstetrician is ready to make the incision, and Syncurine (usually 4 mg.) is given immediately after the patient has lost consciousness. N_2O+O_2 is then given until the baby is born.

When we started to use decamethonium in obstetrical anaesthesia it was our belief, and that of others, that it had no effect on the newborn. Pettinger and Morris, experimenting in dogs, reported that placental transmission of D-tubocurarine had been demonstrated after injection of large doses of the drug into the uterine artery. They claimed, however, that the small amounts of the drug ordinarily employed in obstetrics were without significant effects on human infants. Our experience, however, with nearly 500 cases in which C_{10} was used is in contradiction with what we thought, and what has been reported on the subject.

As we said previously, for a total of 691 mothers receiving Demerol and hyoscine for analgesia the incidence of apnoea in the newborn was 15 per cent. For 254 patients receiving the same dose of Demerol and hyoscine the incidence of asphyxia in the newborn rose to 27 per cent when decamethonium bromide was injected into the mother, a difference of 12 per cent.

So, with identical analgesia, reanimation has been done 12 per cent more often when a relaxing agent like C_{10} had been given to the mother. It is our belief that more experiments will have to be made regarding the effects of curarising agents on the newborn.

Summary

1. The association of Demerol and hyoscine, which is largely used, has been the drug combination least detrimental to the foetus. It can be detrimental when it is repeated or used within one hour of the delivery. Syncopal reactions are also possible which secondarily affect the child.

2. Barbiturates used in large doses, whether it be intravenously or rectally, have a striking or marked depressing effect on the newborn. A small amount (not over 250 mg. of a 2½ per cent solution of Pentothal) given intravenously not sooner than 5 minutes before the birth (as used in Caesarian sections) has a less deleterious effect than a larger dose given rectally.

3. The addition of a potent general anaesthetic like cyclopropane enhanced the danger of foetal asphyxia.

4. Spinal anaesthesia or N_2O alone or supplemented with trilene should be substituted whenever possible.

5. Decamethonium bromide, in spite of some reports, has seemed to affect the newborn.

6. Asphyxia neonotorum and its possible sequelae on the central nervous system is so often produced by barbiturates that their use in obstetrics should be restricted to a minimum. To expect the barbiturates to produce complete amnesia and analgesia for a number of hours and to have no ill effects on the baby is asking too much. Any hospital that wishes to diminish the neonatal mortality rate should, as a first step, banish the barbiturates, especially those given by intravenous and rectal administration, and be careful with curarising agents. These measures are already being applied in our medical group with undeniably good results.

RÉSUMÉ

Nous avons voulu prouver une fois de plus, après tant d'autres, l'effet désastreux des barbituriques sur le nouveau-né en prenant comme guide la fréquence de la réanimation fœtale.

Un relevé de 2605 cas d'anesthésies obstétricales exécutées par le Service d'Anesthésiologie de l'Hôpital St-François d'Assise nous a donné les précisions suivantes:

1. Le démérol 100 mgm. avec l'hyoscine 1/150 associés ou non à un barbiturique par voie orale, administrés ou injectés à la mère plus d'une heure avant l'expulsion, ont nécessité la réanimation du fœtus dans une proportion de 15 pour-cent.

2. L'action des barbituriques par voie rectale s'est avérée funeste à tel point qu'au delà de 35 pour-cent des fœtus durent être réanimés.

3. Le pourcentage de la reanimation fœtale s'est élevé à 50 pour-cent après l'injection intraveineuse de somnifène. Une mort fœtale par hypoxie lui est attribuable.

La rachi-anesthésie a été moins préjudiciable à l'enfant que les anesthésiques généraux tels que le cyclopropane et l'éther.

L'effet de ces derniers ajouté à celui des barbituriques a amené un pourcentage élevé de réanimation chez les nouveau-nés.

Malgré l'opinion généralement établie les curares tel que le C_{10} ont semblé affecter la respiration des nouveau-nés. Si on prend un nombre déterminé de parturientes ayant reçu pendant le travail les mêmes médicaments on trouve un pourcentage de réanimation fœtale plus élevé chez celles à qui on a injecté, par voie intra-veineuse avant l'expulsion, de 2 à 3 mg. de syncurine.

L'impression générale qui se dégage est la suivante: les barbituriques par voie intra-veineuse ou rectale à cause de leur effet nocif sur le nouveau-né n'ont pas leur place en obstétrique. Tout hôpital qui a à cœur de diminuer son taux de mortalité fœtale doit bannir les barbituriques donnés par voie intraveineuse et par voie rectale et être prudent avec les substance curarisantes.

Ces mesures ont déjà été prises dans notre milieu avec des résultats indéniables.

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ANAESTHESIA FOR REPAIR OF CLEFT LIP AND PALATE IN INFANTS USING MODERATE HYPOTHERMIA

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PAEDIATRIC ANAESTHESIA presents many interesting and challenging problems. The smaller the child, the greater are the anatomical and physiological differences between it and the adult, and the more is it necessary to modify anaesthetic techniques. Especially is this so in the presence of congenital malformations of the mouth. Some of the major considerations which apply to infant anaesthesia are: [1] The small tidal exchange renders more significant even a slight degree of mechanical dead space in anaesthetic equipment. [2] The infant tracheobronchial tree has a narrow diameter with its greatest restriction at the cricoid ring rather than at the level of the cords (1). The wall of the endotracheal tube occupies a relatively greater proportion of the available airway thus increasing the resistance to breathing. Also a tube which easily passes the cords may impinge upon the cricoid ring. This can lead to subglottic oedema in the postoperative period. [3] The heat-regulating mechanism of infants is still rather labile. Operative and postoperative hyperpyrexia is therefore common, heat loss being prevented by the sterile sheets which cover the child in a warm operating room. There is loss of body fluids by perspiration, undue fatigue, and in severe instances there may be convulsions. [4] Blood loss becomes very significant because of the small circulating volume. Haemorrhage must therefore be carefully controlled and blood for transfusion should always be available for use if bleeding is excessive. On the other hand, it must be remembered that overtransfusion is a hazard, as the exact blood loss is difficult to estimate.

It has long been recognized that time is an important factor in the surgery of infants and that the margin of safety is generally small. In all methods of anaesthesia described it is emphasized that induction should be smooth and of short duration. It is generally agreed that anaesthesia should be maintained at the lightest possible level; the baby will then awake almost as soon as surgery is completed and the feeding schedule will not be unduly interrupted. Endotracheal intubation in infants requires the skill of experience if hazards are to be avoided; but it is essential in surgery of the mouth and face, the advantages here outweighing the disadvantages and hazards (2, 3). The main advantages of intubation are to be found in the maintenance of a perfect airway with better control of tidal volume; there is thus good elimination of carbon dioxide with reduced tendency to capillary oozing. Intubation also allows a smoother and steadier level of anaesthesia to be maintained and will allow the anaesthetist to keep his equipment well clear of the surgical field.

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Despite all the refinements of modern anaesthesia, the problem of bleeding in operations for cleft lip and palate has still remained with us. This is owing to the exceedingly rich blood supply of the tissues involved. Blood loss is poorly tolerated by small infants and may require transfusion. Even more important perhaps is the fact that bleeding will markedly prolong the duration of the operation, which should, if possible, always be completed within one hour from induction of anaesthesia. Undue prolongation may result in marked deterioration of the child's general condition.

In order to reduce bleeding we have of late started to use hypothermia of moderate degree by means of skin cooling. The apparatus used is the Thermo-Rite unit with cooling blankets. This unit allows for both cooling and heating of the blankets. The cooling apparatus is switched on before the patient is brought up from the ward, so that the temperature of the blanket has reached approximately 70°F by the time the child is placed on it. A pillow is placed under the cooling blanket towards the head end of the table (Fig. 1). The operation is timed in such a way that it follows approximately 3 hours after the last feeding; in this way the feeding schedule is hardly interrupted at all. Atropine Sulphate is given intramuscularly on the ward 45 minutes before induction time. Induction is frequently preceded by basal anaesthesia with

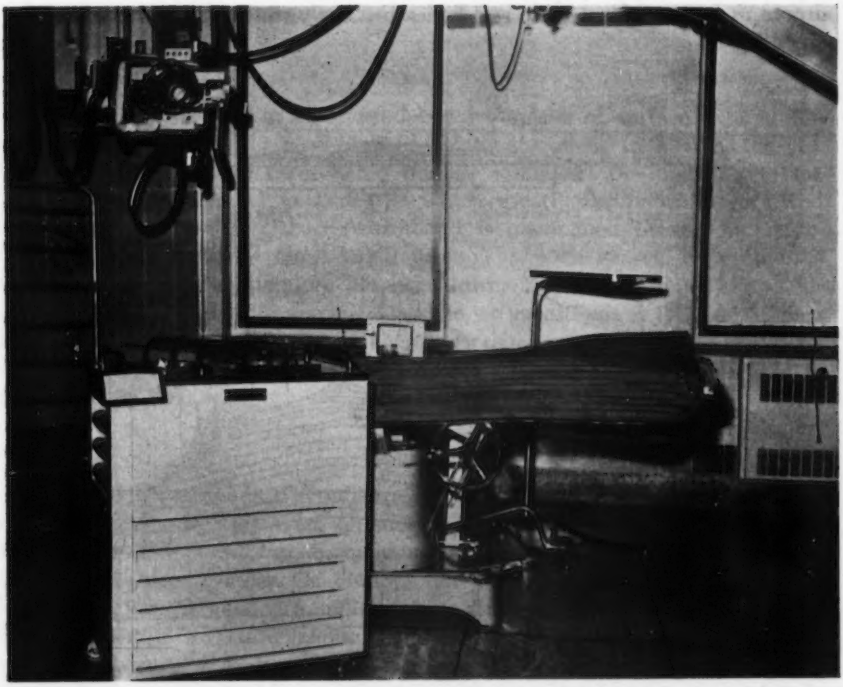

FIGURE 1. Cooling blanket in position with pillow under the head end and electronic thermometer with rectal lead.

rectal thiopental (1 Gm. per 50 lb. body weight as a 10 per cent solution). Anaesthesia itself is induced in one of two ways: either nitrous oxide–oxygen followed by diethyl ether is used, or open drop divinyl ether is followed by diethyl ether and oxygen. When an adequate depth of anaesthesia is reached, intubation is performed by the oral route. One frequently finds that the laryngoscope sinks into the cleft lip and alveolus which results in difficulty in visualizing the larynx. A guard made of folded zinc oxide tape, placed across the cleft alveolus, will help to avoid this difficulty. Great care must be taken at this point to avoid all trauma to soft tissues. The endotracheal tube is a plain black unreinforced Magill tube, and it is connected to a modified Ayre's T-piece (4).

As soon as the infant is intubated he is transferred to the operating table on which the hypothermia blanket has already been cooled and the lead of the electronic thermometer is placed in the rectum. The head is then extended over the pillow at the end of the table. The surgeon now prepares the field of operation and begins to apply the drapes. For operation on the palate the modified Dott's gag is used, which steadies the tube in the mid-line without kinking (5).

A Mayo table is placed above the baby's trunk to keep the weight of the drapes off the body and allow free circulation of air. It also serves its original purpose as an instrument table and beneath it the anaesthetist has access to the baby (Fig. 2).

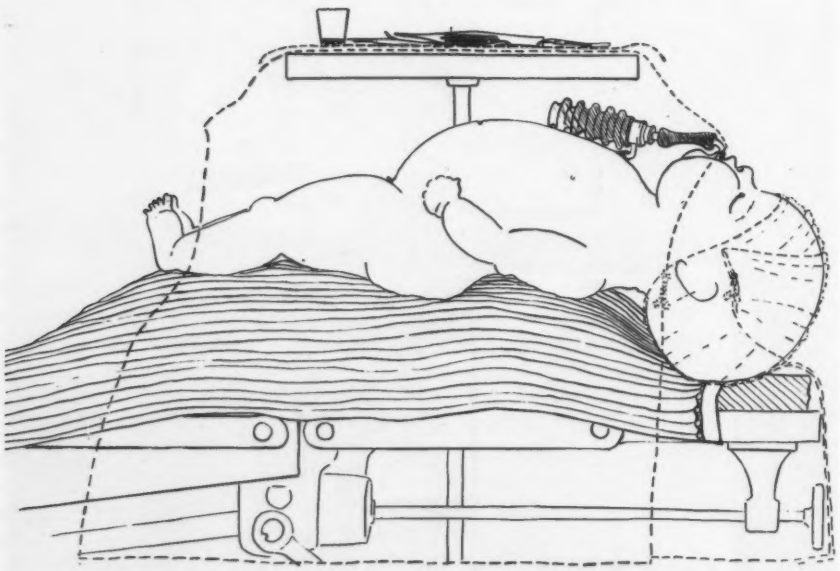

FIGURE 2. Position of infant on the table, intubated, with Ayre's T-piece. The Mayo table is shown and the dotted line indicates the site of the drapes.

Usually within a matter of five minutes the body temperature begins to fall and at this point rewarming of the blanket to 90°F is begun. Within the next 5 to 10 minutes the body temperature tends to reach 93°F. The operation is then begun and anaesthesia is changed over to equal proportions of nitrous oxide and oxygen. The body temperature is maintained in the neighbourhood of 92°F; respirations at that temperature are quiet and slow; the skin is pale pink and dry and pulse tends to be slow. With this technique it has been found that the incision of the tissues is practically bloodless and the only bleeding is from the coronary vessels and from vessels in the nasal floor, all of which are immediately secured. Blood loss is negligible. Towards the end of the operation the blanket is heated, raising the body temperature to about 95°F. The baby will awake immediately upon withdrawal of the anaesthetic mixture. The child is then transferred to the recovery room wrapped in warm blankets and has its first feeding within half an hour of the end of operation. Essentially the same technique is used for repair of both cleft lip and palate.

Both fall and return of body temperature are very rapid in small infants because the heat-regulating mechanism is still labile; it is most important to realize this fact in order to prevent undue depression of temperature. We make it a rule to start an intravenous infusion before the operation is begun in order to have access to a vein for any possible medication. The degree of hypothermia used produces no cardiac irregularities.

Summary

Moderate hypothermia to 93°F produced by means of surface cooling has been used with success in cleft lip and palate operations in infants, the risk of hyperpyrexia in these cases being thereby removed. The bleeding in the operative field is reduced to a degree which greatly facilitates surgery and reduces over-all operating time. Anaesthesia is maintained through an endotracheal tube by means of the Ayre's T-piece. Very little general anaesthesia is required, once body temperature has been lowered. This technique allows for minimum interference in the feeding schedule, as anaesthesia is induced 3 hours after the last feeding and the total anaesthesia time is not allowed to last much over 1 hour. Children are immediately awake on rewarming and are able to talk and retain their feeding.

Résumé

L'emploi de la méthode d'hypothermie légère à 93°F, obtenue par refroidissement périphérique, s'est avéré un succès dans les interventions pour bec-de-lièvre et gueule-de-loup chez les enfants; on élimine ainsi le danger que pose l'hyperthermie dans ces cas. On diminue, en plus, le saignement au niveau du champ opératoire à un degré suffisant pour faciliter l'acte chirurgical et raccourcir le temps de l'intervention. Pour l'anesthésie, on se sert d'un tube endotrachéal attaché à un tube d'Ayre en T. On constate une diminution importante de la quantité des anesthésiques généraux à administrer, une fois la température du corps abaissée. Cette technique offre l'avantage de n'apporter

que des changements minimes à l'horaire des boires, puisqu'on commence l'anesthésie 3 heures après le dernier boire et que le temps total d'anesthésie dépasse rarement 1 heure. Dès qu'ils retrouvent leur température normale, les enfants sont parfaitement réveillés, peuvent parler et garder leur boire.

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COMBINED USE OF NARCOTIC AND NARCOTIC ANTAGONIST IN THE SUPPLEMENTATION OF ANAESTHESIA

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NARCOTIC ANALGETICS and thiopental (Pentothal®) sodium[1] are commonly employed intravenously to supplement nitrous oxide-oxygen anaesthesia. It is often difficult to achieve the optimal balancing of these agents which is a prerequisite to satisfactory anaesthesia. When used in large amounts, thiopental is slowly metabolized and may therefore depress the patient for a period extending well beyond the surgical procedure. Some narcotic analgetics are similarly objectionable because of their long duration of action. Also, these morphine-like compounds may produce severe respiratory depression. It would therefore appear desirable to find some technique which would limit the depressive effects of the anaesthetic and supplementing drugs used to the operative period, lessen the hazard of apnoea, provide good anaesthesia, and yet allow the patient to be easily aroused and free from pain in the immediate postoperative period.

Alphaprodine (Nisentil®) hydrochloride[2] is a potent, short-acting narcotic analgetic which, according to Siker *et al.* (1), has the advantage of excellent controllability when used as supplementary agent to nitrous oxide–oxygen–thiopental anaesthesia. By replacing meperidine (Demerol®) hydrochloride with alphaprodine, these workers were able to reduce significantly the thiopental requirements and to increase considerably the percentage of patients who reacted to stimuli within 5 minutes after termination of surgery. Their attempt to decrease further the thiopental doses by using larger amounts of alphaprodine failed because of the severe respiratory depression encountered. Swerdlow *et al.* (2, 3) showed in unanaesthetized subjects that alphaprodine-induced respiratory depression can be prevented or antagonized to a considerable degree by the narcotic antagonist, levallorphan tartrate[3] (levo-3-hydroxy-N-allylmorphinan tartrate).

Against this background, the idea occurred to Pirk (4, 5) that the combined use of alphaprodine and levallorphan for supplementation of nitrous oxide–oxygen-thiopental anaesthesia may make it possible to administer larger doses of alphaprodine, without producing respiratory depression, and thus to reduce further the thiopental requirements. It was anticipated that in a suitable ratio the narcotic antagonist would not interfere with alphaprodine analgesia and that a reduction of the barbiturate doses would increase the percentage of the patients who react to stimulation postoperatively. Foldes *et al.* (4, 5) have recently reported that, with a technique based on these considerations, alphaprodine doses three to six times greater than those used in their control series

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[1]To be referred to henceforth as thiopental.

[2]To be referred to henceforth as alphaprodine.

[3]To be referred to henceforth as levallorphan. (Lorfan Tartrate T.M.)

were tolerated without producing significant respiratory depression and that the thiopental requirements were reduced by 50 to 100 per cent. As a consequence, better than 80 per cent of the patients obeyed commands within 5 minutes of termination of surgery.

This report describes our experiences with a combination of alphaprodine and levallorphan[4] as supplement to inhalation anaesthesia, with a technique which differed somewhat from that employed by Foldes and collaborators (4, 5). The purpose of the study was to determine if these agents would make it possible to obtain safe, adequate anaesthesia, and yet have the patient awake and in a relatively normal state at the conclusion of anaesthesia.

Case Material and Method of Anaesthesia

The study comprised 252 patients (174 females and 78 males) whose ages ranged from 15 to 79 years (average, 45.9 years). Patients were classified according to risk, using the ASA method, 1 being the best and 7 the poorest risk. Eight cases were in category 5 to 7. Table I classifies the patients according to site of operation. One hundred and sixty-five of the procedures were major operations.

TABLE I

Classification according to Site of Operation performed in 252 patients receiving Nisentil® and Levallorphan as Supplement to Inhalation Anaesthesia

Site of operation	*Number of cases*
Head or neck	38
Thorax	33
Upper abdomen	14
Lower abdomen	48
Abdominal wall	1
Perineum	71
Spine	6
Limbs	41
Total	252

Premedication, given 60–90 minutes before surgery, consisted of 3–15 mg. of morphine sulfate and 0.15–0.4 mg. of scopolamine hydrobromide or atropine sulfate. These drugs were administered hypodermically except with a few patients, scheduled for emergency operations, who received the premedication intravenously.

Nitrous oxide–oxygen was used for 243 patients. Of these, 144 received no other inhalation anaesthetic. Of the 99 patients in whom nitrous oxide–oxygen was supplemented by other agents, 82 were given cyclopropane and 17 ethyl ether. Nine operations were performed under local blocks.

Ten to fifteen minutes before initiation of anaesthesia, alphaprodine and

[4]Supplied for this study as "Rol-7700" through the courtesy of Dr. M. J. Schiffrin, Hoffmann-La Roche Inc.

levallorphan were given intravenously as a premixed solution which contained 12 mg. of the former and 0.24 mg. of the latter agent per cc. (50:1 ratio). The size of the initial dose of this mixture—usually 2.5 to 5 cc. (corresponding to 30 to 60 mg. of alphaprodine)—depended on the age and physical status of the patient. Subsequent doses of 12 mg. of alphaprodine and 0.24 mg. of levallorphan and/or a 2½ per cent solution of thiopental were administered intravenously as required during the operative procedure.

Succinylcholine was used in 53 patients for relaxation or intubation.

The duration of surgery ranged from less than 1 hour to 9¼ hours. It was less than 1 hour in 58; 1 to 2 hours in 83; 2 to 3 hours in 63; 3 to 4 hours in 20; 4 to 5 hours in 15; 5 to 6 hours in 8; and 6 to 9¼ hours in 5 cases.

Results

The total amount of alphaprodine used per patient ranged from 6 to 240 mg. with an average of 73.3 mg. The total amount of thiopental, which was used in but 207 of the 252 cases, ranged from 50 mg. to 775 mg. with an average of 194 mg.

The 53 patients who received succinylcholine required continuous assisted respiration. In 154 patients of the 199 who did not receive succinylcholine, respiration was adequate during the entire surgery. The remainder of 45 (22.6 per cent) experienced different degrees of respiratory depression. Thus, in 15 instances the respiratory rate was temporarily reduced to 8 to 12 per minute; and in 30 cases, marked depression occurred which required manual assistance. This depression of respiration usually occurred after administration of the first dose of the combined alphaprodine-levallorphan solution, but subsequent doses of the combination did not produce this effect. Respirometer studies indicated that the first dose often reduced the minute-volume exchange by as much as 50 per cent for 5 or 6 minutes. The minute volume then increased, approaching control levels. Depression of minute volume tended to be minimal with additional doses of combined alphaprodine-levallorphan.

One hundred and sixty-four patients (65 per cent) were awake and reacted within 3 minutes, and 229 (91 per cent) responded within 5 minutes after completion of surgery. Thus only 23 patients (9 per cent) required more than 5 minutes to react. There were no cases of postoperative respiratory depression. In two instances hives developed at the site of injection of the combined drugs.

Discussion

As mentioned, the technique of the combined use of alphaprodine and levallorphan employed in this study differed somewhat from that devised by Foldes *et al.* (4, 5). These workers, in the great majority of their cases, did not use a premixed combination of alphaprodine and levallorphan but administered 0.02 mg./kg. of the narcotic antagonist first, followed after several minutes by 1 mg./kg. of the analgetic. Subsequent alphaprodine doses were given without the conjoint use of levallorphan. Additional doses of the antagonist were administered only when the duration of surgery exceeded 2 to 3 hours or when there was respiratory depression at the end of surgery. While the initial

alphaprodine-levallorphan ratio was thus always 50:1, the ratio of the total doses of these two agents varied between 60:1 and 120:1, depending on the total dose of alphaprodine and the duration of anaesthesia. Since alphaprodine is metabolized more promptly than levallorphan, it is possible that the ratio of the two agents in circulation at any given time approximated 50:1. On the other hand, it must be assumed that with our technique this ratio was smaller, particularly in instances in which several doses of the mixture of the two drugs were given in the course of anaesthesia. However, this did not lead to an interference with the analgetic effect of alphaprodine or to respiratory depression after operation which might be expected from a cumulative effect of levallorphan, known to depress respiratory function by itself. Probably such consequences did not arise because alphaprodine in the form of the mixture was used more sparingly than the analgetic by Foldes *et al.* (5). For instance, the largest total amount of the premixed drugs given to one patient in our series was 240 mg. of alphaprodine and 4.8 mg. of levallorphan. This maximal analgetic dose is considerably less than 780 mg. used in one case by the other workers. Similarly, the average amounts of alphaprodine and levallorphan employed in our patients, whose surgery lasted more than three hours, was 0.38 mg./min. and 0.0076 mg./min., respectively. In contrast, the average analgetic doses used by the other group ranged from 0.9 ($\pm$ 0.1) to 1.2 ($\pm$ 0.2) mg./min. Had such large doses of alphaprodine been given with our technique, which utilizes a premixed combination of the two drugs, obviously a much greater total dose of levallorphan would have been administered than was the case.

The average alphaprodine dose we needed was probably so much smaller because in over 40 per cent of the cases in which nitrous oxide–oxygen was used, this was supplemented with cyclopropane or ethyl ether. Foldes, on the other hand, limited inhalation anaesthesia to nitrous oxide–oxygen. Yet we used doses of alphaprodine considerably larger than could be given safely without the conjoint administration of levallorphan.

The incidence of depression which required assisted respiration in our patients, who had not received succinylcholine, was 15 per cent. This is a somewhat higher figure than that of 8 per cent reported by Foldes' group. Since respiratory depression usually occurred after the first dose of the alphaprodine-levallorphan solution, one might conjecture that a more complete protection against the respiratory depressing effect of alphaprodine may be assured if the narcotic antagonist is administered several minutes prior to the initial alphaprodine dose.

As for thiopental requirements, satisfactory operating conditions were obtained in 45 patients without the use of barbiturate. The average thiopental dose of 194 mg. was considerably less than that needed with other techniques. For instance, Ausherman *et al.* (6), who used meperdine by continuous drip, employed approximately six times as much thiopental as we did.

The most rewarding aspect of this study was the postoperative course of the patients, which was very similar to that described by Foldes *et al.* (5). Indeed, the fact that over 90 per cent of our patients responded to stimulation with 5 minutes after completion of surgery is an unusual experience. No doubt, this

could be accomplished only by reducing the thiopental requirements, and this in turn was made possible by the use of larger alphaprodine doses which were tolerated without undue respiratory depression because of the conjoint administration of levallorphan.

Summary and Conclusions

1. Alphaprodine (Nisentil®) hydrochloride and levallorphan tartrate were used in a 50:1 ratio as supplement to inhalation anaesthesia in 252 patients.

2. In the dosage employed, this combination is safe and provides good analgesia with a minimum of undesirable effects.

3. The reduction of thiopental requirements and the very high proportion of patients awake and responding within 5 minutes after completion of surgery make the use of this combination desirable in the conduction of balanced anaesthesia.

Résumé

C'est d'usage courant d'employer, par voie intra-veineuse, et des analgésiques narcotiques et du pentothal, pour compléter l'anesthésie au protoxyde et oxygène. On peut toutefois s'objecter à l'emploi de ces agents à cause de la dépression prolongée qu'ils entraînent chez le patient. De là ressort la nécessité de trouver une technique qui, tout en procurant une anesthésie adéquate, limiterait au temps opératoire les effets dépressifs de ces agents, permettrait un réveil facile du patient et protégerait ce dernier contre la douleur dans la période post-opératoire immédiate.

On a employé, chez 252 patients, un mélange de chlorure d'alphaprodine (Nisentil) et de tartrate de lévallorphan dans une proportion de 50:1 comme complément à l'anesthésie par voie d'inhalation. On s'est servi d'une solution contenant un mélange de 12 mgm. d'alphaprodine et de 0.24 mgm. de lévallorphan par cc. Selon l'âge et l'état physique du patient, on administrait de 2.5 à 5 cc. du mélange, dix à quinze minutes avant le début de l'anesthésie. Par la suite, au cours de l'intervention, on répétait des doses de 1 cc. du mélange ou des doses adéquates de pentothal, suivant la nécessité. Chez 53 patients, on a également employé de la succinylcholine, soit au moment de l'intubation, soit pour obtenir un meilleur relâchement musculaire au cours de l'opération; et chez tous ces patients, on a dû recourir à la respiration assistée.

Chez 45 des patients qui n'ont pas reçu de succinylcholine, i.e. 22.6 pour-cent, on a constaté une dépression de la respiration; 30 de ceux-ci ont présenté une dépression assez importante pour nécessiter une assistance manuelle. Cette dépression de la respiration se produisait généralement après l'administration de la première dose du mélange alphaprodine-lévallorphan. Seulement 23 patients ont pris plus de 5 minutes à réagir, une fois l'opération terminée; il n'y eut aucun cas de dépression respiratoire post-opératoire. Dans l'ensemble, les patients ont eu besoin de doses moindres de pentothal.

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A NEW MANUAL RESPIRATOR

IAIN M. MACKAY, M.D., F.A.C.A.*

A CONSIDERABLE VARIETY of respirators is in use today for ventilation of the anaesthetized subject. Some are mechanically, some manually operated. While recognizing the deserved popularity of the mechanical type I believe that the manual respirator has its place in clinical anaesthesia.

The device presented here requires no motive power other than the hand of the anaesthetist. This is, of course, an apparent disadvantage as the anaesthetist must himself ventilate the patient throughout the procedure. However, our experience has shown us the desirability of providing an assistant for most intrathoracic cases, even when the anaesthetist is equipped with a mechanical respirator. We have also found that the device described below causes much less fatigue in arm and hand than ventilation by the ordinary method, using the standard large bag of the Heidbrink or other circle absorption machine.

Neither compressed gases nor suction are required for operation of this respirator. It will adapt readily to any anaesthetic gas machine using either circle absorption or to-and-fro absorption of carbon dioxide. Either the closed system with maximal carbon dioxide absorption or a high gas flow and carbon dioxide blow-off may be used.

Another advantage of this device is its simplicity. Damage to the apparatus is unlikely and repair is not difficult. Spare parts are easily obtained although seldom required. All necessary cleaning and sterilization may be done easily.

A very important advantage is the low cost of this respirator in comparison with the mechanical apparati. This is, of course, of great importance in the large hospital in which there may be four or five intrathoracic procedures in progress at one time. The high cost of the mechanical ventilators may make their purchase in quantity impossible, whereas several respirators of the type described here could be made available for the price of one automatic ventilator.

The device consists essentially of a standard Coxeter-Mushin bellows. This has been hinged to impart stability and can be clamped to the edge of an operating table (Fig. 1). The hinge is devised to open automatically if the bellows overfills and may be opened with one motion of the hand if a free bellows is desired. A handstrap is attached to the bellows top.

The bellows is connected by a length of standard, wide-bore, corrugated rubber tubing and a special bag-mount to a gas machine (Fig. 2). As illustrated the bag-mount carries a standard Heidbrink rebreathing bag. A two-way wide-bore valve, interposed between the two bags, allows either an intermittent positive pressure technique or alternating positive and negative pressures to be used at any time. An air intake valve is inserted in the bag-mount. If it is desired the bellows may be fitted directly onto the special bag-mount so that it projects to the side of the absorber.

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FIGURE 1. The hand-operated ventilating Bellows of the respirator clamped to the head of an operating table.

An aneroid manometer is attached by a length of flexible rubber tubing to a wide-bore T-piece introduced into the respiratory circuit just proximal to the endotracheal tube (Fig. 2). Positive pressures are regulated by the expiratory valve of the gas machine. Negative pressures are determined from the manometer.

The apparatus described above has been used in more than sixty surgical procedures during the past eight months. Approximately two-thirds were intrathoracic procedures; most of the others, upper abdominal.

Pressures ranging from + 20 cm. H_2O to — 10 cm. H_2O were used in these cases. In some, only intermittent positive pressure was utilized but in the majority both positive and negative pressures were used.

Apnoea is easily achieved and maintained with this apparatus. Arterial and venous pH levels have been determined in several patients undergoing upper abdominal or intrathoracic surgery. A pH of 7.5 was consistently achieved in this series. In one case, by deliberate over-ventilation, a venous pH of 7.7 was attained indicating a probable arterial pH of 7.8 or more and a true respiratory

FIGURE 2. The respirator equipment is shown in use, attached to the head of a Heidbrink anaesthetic gas machine.

alkalosis, the normal range of blood pH being between 7.35 and 7.45. Although a high degree of alkalaemia is not necessarily desirable this demonstrates the efficiency of the apparatus in carbon dioxide elimination.

A patient's earliest attempt to escape from respiratory control can be immediately detected by the hand of the operator and corrected much more quickly than is possible with a mechanical respirator; he can prevent the patient from having to "fight" control. With the mechanical type of respirator such escape is not so likely to occur due to the almost invariable induction of a true respiratory alkalosis. The desirability of this is subject to debate.

The direct control which the anaesthetist has over the manual respirator allows the lung to be immobilized immediately at any point in either phase of respiration and held still for as long as is required by the surgeon. Mediastinal movement may, of course, be minimized in the same way, more easily than with a mechanical device.

The apparatus discussed above was made to my specifications by British Oxygen Canada Limited. They are prepared to supply a somewhat more streamlined model on order and at low cost.

Summary

In spite of the popularity of mechanical respirators today the manual respirator is still of value. A new device of the latter type is described here, exhibiting the desirable features of adaptability to any gas machine, circuit or ventilation technique; simplicity of construction and design; low cost and economy of operation; portability; and efficiency in both oxygenation and carbon dioxide elimination.

Résumé

Bien que le respirateur mécanique jouisse d'une grande popularité aujourd'hui, le respirateur opéré manuellement a aussi une place en anesthésie.

Il est moins fatiguant à employer que le ballon de la machine à gaz régulière, le modèle décrit ci-contre s'adapte à toute méthode de ventilation et ne requiert pas d'autre source de gaz ou d'énergie. Le dessin en est simple. La réparation, si elle devient nécessaire, peut se faire facilement et il en est ainsi pour le nettoyage et la stérilisation de l'appareil. Son prix modique lui donne un avantage bien défini sur le respirateur type mécanique.

Le plan consiste en un genre d'accordéon qui peut être fixé à la table d'opération ou inséré dans la machine à gaz (Fig. 1). Une longueur de tubes de caoutchouc ordinaires, de large diamètre et un embout spécial complètent le montage (Fig. 2). Une valve à deux directions permet l'emploi de l'un ou l'autre des deux ballons. Des pressions intrapulmonaires variant entre + 20 cm. d'H_2O et — 10 cm. d'H_2O sont employées et sont enregistrées par un manomètre aneroïde attaché au circuit par un tube en T à grandes ouvertures (Fig. 2).

On peut obtenir facilement une apnée avec cet appareil et on peut maintenir expérimentalement un pH sanguin de 7.5 et plus. A part cela, il est possible de découvrir et de corriger rapidement les fuites provenant du contrôle respiratoire. Avec cet appareil, on peut réduire à volonté les mouvements du poumon et du médiastin.

On peut se procurer ce respirateur à prix modique à la compagnie "British Oxygen Canada Ltd."

SPINAL ANAESTHESIA: A RE-EVALUATION*

WILLIAM G. MACKERSIE, M.D.**

EACH SURGICAL PATIENT presents a different problem and the anaesthesist in choosing his method must decide:

1. What is safe?
2. What will have a minimum of side effects?
3. What will give the surgeon the best working conditions and facilitate the surgery?
4. Do the disadvantages of the method outweigh the advantages?

Much has been written regarding spinal anaesthesia and there is still much disagreement as to its rightful place in our practice. The possibility of neurological complications has been the greatest deterrent to its use.

Spinal anaesthesia provides complete anaesthesia, maximum relaxation, and a minimum disturbance of metabolism.

How safe is the method? C. R. Stephen (1) has stated: "Spinal anaesthesia may be considered as safe as any method of pain relief, provided meticulous care is observed, common sense is exercised, and the technique is reserved for patients who want it, surgeons who desire it, and anaesthetists who can perform it intelligently." Also, R. R. MacIntosh (2) writes: "Spinal anaesthesia is no more and no less dangerous than general."

Recently Dripps and Van Dam (3) reported their follow-up on 10,098 spinal anaesthetics and their failure to discover major neurological sequelae; Bittrich's (4) series of 6,000 spinal anaesthetics in obstetrics without any major complications is evidence that the incidence of neurological tragedies can be minimized.

In 1950, Foster Kennedy (5) published his report on major neurological complications following spinal anaesthesia. Six of the eleven patients he saw had received continuous spinal anaesthesia.

Meningitis has followed the use of syringes sterilized by lying in an alcohol solution and arachnoitis resulted from the use of ampules sterilized in a phenol solution. Cauda Equina syndromes have followed the use of nupercaine 1:200 used for saddle block. These are all developments that could have been avoided.

Spinal anaesthesia requires strict adherence to proper techniques:

1. The patient should be visited before surgery and cardio-vascular and respiratory status should be evaluated. Do not urge this technique if he objects. Note blood pressure, haemoglobin, and R.B.C. Older patients who have lost weight or have carcinoma may have a low blood volume. Blood should be given before surgery. Is pain out of proportion to the disease? Is there a history of previous neurological disease such as poliomyelitis, syphilis, or meningitis? If there is, avoid spinal anaesthesia.

*Presented at a Meeting of the Ontario Division, Canadian Anaesthetists' Society, Windsor, Ontario, October 22, 1955.

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2. The patient should be comfortable on the table and care should be used in moving him or changing his position on the table. Sacroiliac joints have been strained and the patient will believe it is all due to the spinal puncture.

3. Everything used should be autoclaved. We place the ampules to be used for a spinal anaesthetic in a large test-tube and autoclave at 20 lb. for 5 minutes We have not noticed any deterioration in potency.

4. Only the minimum amount of drug necessary for anaesthesia should be used and never in high concentration.

5. Needles, should be used which will cause the least injury to the dura. Avoid multiple punctures.

6. The method should be stopped if the patient complains of persistent pain, either in back or radiating down the leg.

7. Careful watch should be kept for any embarrassment of circulation or respiration.

8. Equipment should be at hand to meet any emergency.

9. The patient should be kept well hydrated; give fluids intravenously on the table and encourage him to drink afterwards or see that he gets 3000 cc. intravenously, daily.

10. The patient should be horizontal for 6 to 8 hours after operation but he should move from side to side as soon as anaesthesia has worn off. This will help to avoid backaches.

We are reporting our experience with 1,255 consecutive cases. These represent about 17 per cent of our surgical boardings. Ages range from 16 years to 86 years. Eleven per cent were for surgery of the upper abdomen—gastric resections, cholecystectomies, perforated ulcers, hemicolectomies; 49 per cent lower abdomen—hernias, appendectomies, prostatectomies, abdominal perineal resections, and Caesarean sections; 40 per cent ano-rectal surgery and surgery of the extremities—amputations, arthrotomies, hip prosthesis, vein strippings.

Premedication for the average case has been pentobarbital, gr. 1½ at bedtime and two hours prior to surgery, and morphine sulphate gr. ⅙ or Demerol 100 mg. with Atropine gr. 1/150 one hour before surgery.

Pontocaine has been the anaesthetic of choice in all cases. The 1 per cent solution was used in combination with 1½ to 2 times its volume of 10 per cent Dextrose. If more than 1½ hours of anaesthesia were required, ¼ cc. Epinephrine 1:1000 was added.

Patients who were operated on in the lateral position were given pontocaine diluted to 10 cc. with warm distilled water. The table was kept in reverse Trendelenburg till anaesthesia was sufficiently high and then turned to Trendelenburg.

If the Trendelenburg position were required for a long anaesthetic, Pontocaine solution with 0.25 cc. Epinephrine and 0.75 cc. Dextrose 10 per cent was placed in a 5 cc. syringe and sufficient cerebrospinal fluid withdrawn to make 5 cc. It was then barbotaged by injecting 2 cc. and withdrawing 1 cc. and repeating until the syringe was emptied. This gives anaesthesia to dorsal 6 or 7 and the anaesthesia does not shift with change of position of the patient.

Dosage

Upper abdomen: 10-15 mg. If Epinephrine is added, usually 10–12 mg. which give 3 hours of anaesthesia.

Lower abdomen: 7–12 mg. Here 12 mg. with Epinephrine will give 4 hours for abdominal perineal resections.

Ano-rectal: 4–5 mg. will give 1½ hours of anaesthesia.

Extremities: 8–10 mg. with Epinephrine will give 4 hours of anaesthesia for bilateral vein stripping.

Technique of Puncture

Nearly all have been done in the lateral position. A well-premedicated patient, if asked to sit up, may feel faint and become nauseated.

The patient's back was sterilized with tincture of mercresin and the site of the puncture injected with a mixture of 25 to 50 mg. of Ephedrine and 2 cc. of 1 per cent procaine to provide local anaesthesia. Should the patient complain of persistent pain when the spinal needle is introduced the method should be abandoned. This has not happened in our series.

We used a long bevel 1¼" 18G needle as a guide. It was passed through the ligamentum flavum, usually between L 3/4. A 22G spinal needle can be passed through this without being deflected and if one does not enter the spinal canal on the first try, the spinal needle only is withdrawn a short distance and the direction changed by moving the guide needle. This avoids multiple punctures of the ligamentum flavum, a contributing cause to backache.

Much has been written regarding the relationship of puncture of the dura to headache. We have used various types of spinal needles with the following results.

In 23 cases using the Tuohy catheter technique employing a 16G spinal needle, there were two headaches—one being severe, lasting two to three weeks.

Prior to this series, we had used 26G needles in a number of cases. No patient had a headache, but the technique was more difficult and there was a wait of 30 to 60 seconds before spinal fluid was seen. Movement of the patient during this wait might break a fine needle.

Haraldson and Whitacre had both reported the use of a pencil-point needle which had a hole on the side. With this they experienced a considerable reduction in the precentage of headaches. We postponed using this type of needle until a 22G size was available. The pencil-point is welded to the shaft of the needle and apparently presents manufacturing difficulties as Becton, Dickensen & Co. have discontinued making this item.

Using this needle 896 times, there have been six patients who complained of headaches—3 hemorrhoidectomies, 2 herniorrhaphies, and one incision and drainage of an abdominal-wall abscess. Two of these were patients who had become dehydrated. One of them was immediately cured with 1,000 cc. of 5 per cent Dextrose in distilled water, intravenously. Two were relieved with Empirin Compound tablets. Only one headache was moderately severe; in this case there had been difficulty in doing the spinal tap and two spaces had been

punctured. All these patients had recovered within seven days. This group includes 27 Caesarean sections; none of these patients experienced a headache.

A 22G needle, with the usual bevel, was used in 227 cases. There were no headaches in the abdominal cases, but 3 in 89 patients who were operated on for hernias and hemorrhoids.

A 24G needle was used 49 times and two headaches are recorded.

Since the 22G pencil-point needle is no longer available, we have recently been using a 22G Green needle. This needle is sharpened in 3 quadrants. We have used it 38 times without a headache being reported.

We tried to see all our cases on three successive days following surgery. All patients were asked if they had any complaints and if they had been out of bed (nearly all patients are up within 24 hours of surgery). We did not ask directly "Do you have a headache?" We feel that if the patient has been up and has a spinal headache, he will tell you about it. The floor nurses were asked to report any complaints to them of headache and they have been co-operative.

Besides the type of needle, hydration has been an important factor. All patients, other than those with saddle blocks, received 1,000 cc. 5 per cent Dextrose in distilled water, intravenously. This was started immediately after completion of the anaesthetic. In case of a severe drop in pressure, Ephedrine in 10 mg. doses can be injected into the tubing. Oxygen 100 per cent is also given by mask at the same time. Drops in pressure have not caused so much alarm since the advent of hypotension and total spinal techniques.

Anaesthesia, sufficiently high to cause apnoea, occurred twice. The table was placed in slight reverse Trendelenburg and artificial respiration undertaken with a gas machine, using the "educated hand." In neither case was there an unusual fall in blood pressure and normal respirations were established within 30 minutes. Meanwhile, surgery progressed without the surgeon being aware of the situation.

Nearly all patients wish to be asleep during surgery. Most were given 100 to 200 mg. of Sodium Nembutal as soon as a satisfactory height of anaesthesia had been established. Small doses of Pentothal Sodium, rarely exceeding 400 mg., were added subsequently, In all upper abdominal cases, and many others, there was also a supplement with a 50–50 mixture of nitrous oxide and oxygen. Respirations must be watched carefully and assisted if there is any evidence of hypoxia or hypercardia. The majority of patients were awake before leaving the operating room.

On returning to their rooms, patients are allowed a pillow but they remain in an horizontal position for 6 to 8 hours. However, they are asked to turn in bed as soon as the anaesthetic wears off, and urged to take fluids freely, if there is no contraindication.

Backaches have not been a problem. On the table the patient's head is raised on a pillow and, if the back is not touching the table, padding is placed under the spine. Care should be taken in handling the patient as the sacroiliac joints can easily be strained. Some patients have noticed a tenderness over the site of the puncture when getting a back-rub.

There was one case of foot drop following a continuous spinal anaesthetic with the catheter technique. This completely cleared in 8 weeks. We no longer

employ continuous spinal techniques since the addition of Epinephrine gives sufficient time for nearly all cases.

A considerable number of herniorrhaphies and hemorrhordectomies required catheterization once or twice, but this was also the case when general anaesthesia was used.

Summary

Spinal anaesthesia provides complete anaesthesia, maximum relaxation, and a minimum disturbance of metabolism. There is still much disagreement as to its rightful place in our practice; the possibility of neurological complications has been the greatest deterrent to its use.

Spinal anaesthesia requires strict adherence to proper technique. Such technique may be summarized as follows:

1. Choose the patient intelligently.
2. Asepsis is mandatory.
3. Avoid traumatizing the patient.
4. Use needles which will cause the least injury to the dura.
5. Keep the patient well hydrated and comfortable.

Experience with 1,255 consecutive cases of spinal anaesthesia is reported.

Résumé

La rachianesthésie donne une anesthésie complète, un relachement maximum et ne dérange qu'au minimum le métabolisme. Il existe encore beaucoup de controverse sur le rôle qu'elle doit jouer dans notre pratique, la possibilité de séquelles neurologiques étant le plus fort argument contre son emploi.

La rachianesthésie commande la plus rigoureuse technique. Cette technique peut se résumer ainsi:

1. Choisir les malades de façon intelligente.
2. Suivre une technique des plus aseptiques.
3. Eviter tout traumatisme chez le malade.
4. Ne pas employer d'aiguilles susceptibles de blesser les méninges.
5. Maintenir une bonne hydratation chez le malade et voir à son confort.

Nous faisons part de notre expérience sur 1,255 cas consécutifs de rachianesthésie.

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SPONTANEOUS RUPTURE OF THE OESOPHAGUS FOLLOWING ANAESTHESIA

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FIRST DESCRIBED by Boerhaave in 1724, spontaneous rupture of the oesophagus is a disaster of rare occurrence, and only a few cases have been reported following anaesthesia (1).

A 56-year-old woman was admitted to the Vancouver General Hospital with the complaint of severe difficulty in breathing. Forty-eight hours previously she had had a haemorrhoidectomy performed under general anaesthesia in another hospital. During the post-anaesthetic recovery period the patient had vomited and complained shortly afterwards of a pain bilaterally over the lower chest which radiated between the shoulders; the pain was aggravated by movement.

Examination on admission revealed a well-developed white female in moderate respiratory distress and showing a slight diffuse cyanosis. The interne noted that she was alert and co-operative. The B.P. was 80/40; respiration 36 per minute; pulse 140 per minute; temperature 100°F. The only significant physical findings were: (1) some subcutaneous emphysema about the neck; (2) bilateral basal atelectasis.

The patient was seen on the ward by the consulting anaesthetist on duty, and was intubated under local anaesthesia. A considerable quantity of mucus was aspirated from the trachea. Positive pressure oxygen was administered and under this régime the patient seemed to improve. A chest surgeon was consulted who felt her condition was too poor for surgery though he suspected a ruptured oesophagus. She was taken to the operating room where bronchoscopy was performed under local anaesthesia. This revealed spasm of the lower trachea and swelling of the mucous membrane. Toilet of the lower bronchi removed more mucus.

Following this the patient sat up and coughed up further amounts of mucus; she was sent to the recovery room and maintained on intermittent positive pressure oxygen and neosynephrine–isuprel aerosol.

Her condition remained unchanged and she was returned to the ward the following morning, where during the day she was given A.C.T.H. (25 mg.) in 1000 cc. 5 per cent Dextrose in water.

The following day, she deteriorated and became semi-comatose and a repeat bronchoscopic examination was performed; this revealed a lessening of the oedema and very little in the way of secretions.

In the recovery room she was once again placed on intermittent positive pressure oxygen and aerosol.

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She deteriorated during the night; her B.P. fell from 140/90 to 90/60; her pulse became weak and thready and she died at 7:00 A.M. the third day after admission.

Laboratory examinations during admission:

Urinalysis—normal

Total white cell count 12,850

Differential		
	polys	40%
	staff	46%
	lymphocytes	10%
	monocytes	4%

E.C.G.—Day following admission: suggestive of antero-lateral infarction. Two days following admission: no further evidence to support the possible infarction.

Chest X-rays on the day of admission revealed the following: surgical emphysema in the neck and superior mediastinum; at least two collections of air and fluid in the left side of the chest, presumably in the pleural cavity; a small effusion in the right chest. These were felt to suggest a ruptured oesophagus or bronchopneumonia plus a ruptured emphysematous bulla. The following day the changes were slightly more pronounced.

Post mortem examination revealed the immediate cause of death as pulmonary atelectasis due to mediastinitis from perforation of the oesophagus with contributory empyema and pericarditis. The lesion in the oesophagus was a vertical tear, 1 cm. long, on the left side just above the diaphragm. There was a recent haemorrhoidectomy.

Postoperative emphysema, as was found in this patient, may be due to one of three mechanisms:

1. Rupture of the pharynx or cervical oesophagus due to trauma, for example intubation, gastroscopic examination, etc.
2. Rupture of trachea, bronchus, or bulla.
3. Spontaneous rupture of the oesophagus from increased intraluminal pressure, for example, vomiting and conceivable forcing of anaesthetic gas into the oesophagus.

This paper will consider only spontaneous rupture of the oesophagus.

Incidence

The incidence of spontaneous rupture of the oesophagus, not associated with trauma, is a rare occurrence, but seems to be increasing in frequency, probably owing to more accurate diagnosis. Cram (2) gives an excellent review of the literature on the topic. The patients are usually over 40 years of age, though a case has been reported in an infant of 5 months (10). Eighty to eighty-six per cent of cases are males.

Etiology

Although there is often a preceding history of alcoholism, ulcer or oesophagitis, rupture may occur in a perfectly healthy individual. It is usually precipitated by

vomiting, retching, or defecation especially after a heavy meal. However, vomiting may occur after the severe pain and may be the result of rupture rather than the cause.

Pathogenesis

Ninety per cent of cases occur supra-diaphragmatically and of these, 80 per cent are on the left. Only one case is reported in the literature of perforation in the upper third. This pattern of occurrence has been attributed to several factors by different authors (2, 3, 7), for at this level: (1) the muscle of the oesophagus has become smooth; (2) the oesophagus turns to the right; (3) muscle fibres splay out over the cardia of the stomach; (4) the trachea is no longer supporting it; (5) blood vessels and nerves enter; (6) segmental defects are found in the circular muscle layer at the lower end of the oesophagus in some cadavers. Added to this, Anderson (3) reports four cases, all of whom had a lowered plasma protein with a reversal of the A.G. ratio. It has been shown in fresh cadavers (8) that this is the weakest point in the oesophagus—here it will only tolerate 4.5–7.4 (average 5.0) lb. pressure. (The child's oesophagus will tolerate twice the pressure and possibly accounts for the lower incidence in the young.) The rapidity of the increase of pressure is probably more important than the actual pressure.

Symptoms and Signs (9)

1. Severe retro-sternal or upper abdominal pain, often tearing in nature, radiating to the back in the intra-scapular area (about T10 level), during or *after* vomiting.
2. Vomiting most frequently in a male following a heavy meal. The vomitus may show some bright red blood and may disappear after the onset of pain.
3. Rapidly increasing dyspnoea and cyanosis.
4. Signs of shock, though B.P. may remain normal for some time.
5. 50 per cent show surgical emphysema (mediastinal and cervical).
6. Chest signs vary with air and fluid levels.
7. Abdominal rigidity and tenderness have a high incidence especially in the early stages.
8. X-rays show mediastinal emphysema and hydropneumothorax (uni- or bilateral).
9. Thoracentesis may reveal gastric secretions.

Bante considers the triad of rapid respiratory rate, rigid abdomen, and subcutaneous emphysema as practically pathognomanic of ruptured oesophagus.

Mackler's (7) triad consists of vomiting, low thoracic pain, and emphysema of the neck.

Differential Diagnosis

There are many catastropes with which it may be confused; the most frequent are, in order of frequency of mis-diagnosis:

1. Perforated peptic ulcer. In these there is usually, but not necessarily, a history of gastro-intestinal disease; on examination there is air subdiaphragmatically which is never seen with a ruptured oesophagus. Respiratory symptoms and signs are absent.

2. Perforated diaphragmatic hernia ulcer. This may be differentiated by fluoroscopy and a Barium swallow. Treatment is the same and it is of little importance to diagnose it.

3. Acute pancreatitis. Pleural effusion may occur, and abdominal pain and shock may be marked. The serum amylase is usually elevated and emphysema does not occur.

4. Coronary thrombosis. This is diagnosed on the basis of known cardiovascular disease, characteristic pain, and E.C.A. and fewer, if any, chest signs.

5. Spontaneous mediastinal emphysema.

6. Ruptured bronchus with surgical emphysema. Here there are no gastro-intestinal symptoms, the emphysema and pain are severe. Though initially there is no fluid, this may form later.

7. Spontaneous pneumothorax. It may cause the same symptoms, but they are not as severe. Subcutaneous emphysema is rare.

8. Pneumonia or empyaema.

9. Pulmonary infarct or embolus. No emphysema occurs; cough and haemoptysis are not seen in rupture of the oesophagus. Abdominal pain and rigidity are less marked if present.

Diagnosis

This rests on the symptoms and signs, radiological examination revealing emphysema and fluid, Barium swallow showing leak into the mediastinum and pleural cavity, and thoracenthesis aspirating gastric contents.

Treatment

Some patients will recover with conservative therapy (for example, gastric suction, antibiotics, thoracic drainage, etc.), but since Barrett (4) reported the first case of surgical cure in 1947, this has been considered the treatment of choice. In these, the recovery is 50%.

Summary

A case report of an unusual sequel to anaesthesia has been presented with a brief review of the literature on spontaneous rupture of the oesophagus.

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METHODS OF INDUCING HYPOTENSION*

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THE ESSENTIAL PROBLEM in the induction of hypotension is to make the cardiovascular system too big for the amount of blood it contains. It is possible to do this by reducing the total blood volume. It is also possible to attain this end by increasing the capacity of the vascular bed, and both methods have in fact been used.

The removal of blood to cause fall in blood pressure and therefore reduction in the amount of bleeding at surgical operations, was pioneered by Gardner and Hale of Cleveland nearly ten years ago, but even prior to this time a certain number of anaesthetists had deliberately under-transfused those who had lost blood in order to minimize further bleeding. The margin of safety between safe and excessive hypotension was, however, exceedingly small, and a relatively slight additional blood loss was liable to lower the blood pressure to levels which threatened permanent impairment of renal and possibly also of cardiac function. The contribution of Gardner and Hale (1), which made induced hypotension practicable for the first time, was the introduction of arterial canulation. This allowed much more accurate control of the degree of hypotension induced and afforded a certain method of immediately restoring the blood pressure to safe levels should any manifestation of intolerance appear.

The apparatus required for this technique of hypotension is, however, complicated and difficult to maintain. Also canulation of the radial artery is occasionally followed by circulatory insufficiency and even gangrene of the finger tips, and for these and other reasons, the method, though it gave satisfactory results in the hands of those who used it frequently, was generally regarded as either too complicated or too dangerous for routine clinical use.

The second possible approach to hypotension consists in the production of widespread vasodilatation. Let me remind you for a moment of the anatomy of the vasomotor control of the blood vessels. The main governing centres of this are found in the hypothalamus. Thence the efferents run down to the vasomotor centres in the medulla oblongata and from these to a second cell station in the intermedio-lateral column of grey matter in the spinal cord. The vasomotor efferent fibres leave the cord in the white rami communicantes which run to the ganglionated sympathetic cord in the thorax and abdomen. There is another relay here and the fibres are thereafter distributed to the periphery, either in the peri-arterial sympathetic plexuses or in the named nerves.

The vasomotor mechanism is vulnerable to paralysis by drugs throughout most of its extent. Thus hypotension can be induced by the administration of chlor-

*From a Round Table discussion on "What is the Place of Induced Hypotension in Anaesthesia?" under the direction of Dr. Wesley Bourne, held at the Annual Meeting of the Canadian Anaesthetists' Society in the Banting Institute of the University of Toronto, June 20, 21, and 22, 1955.

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promazine, which depresses the function of the hypothalmic centres. Vasomotor instability is a regular accompaniment of the other medullary actions of analgesic drugs, such as morphine and pethidine (Demerol®), and it is not uncommon for the blood pressure to fall when the latter of these agents is used as a supplement to nitrous oxide and oxygen in a patient whose head is raised. These types of vasomotor paralysis are, however, too incomplete and too capricious in their incidence to make their routine use feasible. There is, however, no reason why hypotension arising fortuitously from one of these causes should not be employed to minimize blood loss during a surgical operation.

If it is necessary to obtain hypotension with comparative certainty, more peripheral block of the vasomotor system is required. For this purpose Gillies (2) and his colleagues in Edinburgh developed the technique of total spinal anaesthesia—although I should also like to draw attention in this connection to the work of the Canadian anaesthetists who have used spinal anaesthesia in major chest surgery since 1936 (3), and often left the accompanying hypotension relatively untreated to minimize blood loss. I have no personal experience of deliberate induction of low blood pressure by the subarachnoid injection of local anaesthetic drugs, but it seems to me that it is probably the most certain method of obtaining this result. The great drawback to it lies partly in the neurological complications which are liable to result from the method, and even more in the medico-legal results of such complications. I refer those of you who seek technical details to the excellent papers of Gillies and his co-workers on this subject.

Probably the most popular method of inducing hypotension for surgery, is block of the transmission in the ganglia of the sympathetic chain. The passage of impulses across synapses there is mediated by acetyl choline, and it is therefore susceptible to block by quaternary ammonium compounds of suitable structure. The best-known agents for this purpose are penta- and hexamethonium (4, 5), but other substances such as pendiomid (6) and pentolinium tartrate (7) have been used for the same purpose. These drugs, however, possess several disadvantages. First, the response to them is exceedingly variable and a dose which gives virtually no result in one patient may produce alarming, if not lethal, fall in blood pressure in another. Secondly, tachyphylaxis to all these agents develops rapidly, and it is virtually impossible to give them in fractional doses until the desired effect is obtained. Thirdly, the effect of a single dose may last anything from 40 minutes to several hours. Some degree of reversal of their action can, it is true, be obtained by inverting the patient and giving methedrine, but even so a pronounced vasomotor instability will persist for some hours after the administration of agents of this type. Patients must in consequence be most carefully postured after operation, at least until pupillary dilatation is gone.

My own technique of giving hexamethonium is as follows. A test dose of 20 mg. of the drug is given and the pressure changes followed carefully over the next 10 minutes. Thereafter a second dose which varies from 20 to 100 mg. is injected. The actual amount depends on the fall in blood pressure produced by the test dose. Little additional blood pressure fall can be expected from further doses of the drug and in resistant patients either increasing the head-up

slope or deepening the anaesthetic is all that can be done to increase the amount of hypotension.

When really major hypotension is required, for example, a blood pressure of 55 mm. of mercury for the ligation or clipping of an intracranial aneurysm, hexamethonium frequently proves insufficient. Several methods of overcoming this drawback have been described. Hewer (8) has suggested simple venesection. Saunders (9) has described a sort of negative pressure plethysmograph chamber which is applied to the lower limbs. Mason and Pellmore (10) suggested the use of procaine amide as a means of reinforcing hexamethonium, and showed that it was very effective. It is, however, my opinion that procaine amide owes its action to a poisonous effect on the myacardium, and I, for one, lack the courage to inflict on my patients the combined disabilities of inadequate coronary blood flow and direct poisoning of the cardiac muscle. It is noteworthy that sudden death has followed the injection of procaine amide both in cardiological (11) and in anaesthetic practice.

A considerable advance was attained in the induction of hypotension when Arfonad became available; for this agent not merely paralyses the ganglia but also has a peripheral vasodilatator effect on the walls of the smaller blood vessels. It is thus considerably more potent and more reliable than hexamethonium. Tachyphylaxis to its action can develop, though this can usually be overwhelmed by increasing dosage, Arfonad is extremely rapidly destroyed in the body and the prolonged period of vasomotor instability which is liable to follow the administration of hexamethonium and the other ganglion blocking agents, does not appear when this substance is used.

Arfonad (12) is given by intravenous drip in saline. The strength of the solution may vary from 0.5 to 1.5 mg. per ml. depending on the probable response of the patient to the drug; it is always necessary to slow down the drip rate markedly as soon as the blood pressure begins to fall in order to avoid the danger of excessive dosage, because allowance must be made for the action of those quantities of the drug which, although already injected into the vein, have not had time to exert their therapeutic effect. This safety pause is especially necessary when the drug is being injected into the saphenous at the ankle to allow for the long circulatory path which the drug must traverse before it reaches the point of its action.

Arfonad will, however, fail occasionally in the very robust, and apart from spinal anaesthesia, there is no method which offers real certainty in such cases. The depth of the accompanying general anaesthesia profoundly modifies the action of Arfonad as of all hypotensive agents. For this reason the first manoeuvre which should be adopted to deal with the apparent development of resistance, is administration of more general anaesthetic. It is also desirable not to replace all the lost blood in a patient who is proving or seems likely to prove resistant to the drug.

Finally, there are a few other methods of inducing hypotension which may have a place, or may yet win themselves a place in anaesthesia. During the operation for the removal of a phaeochromocytoma, the administration of a ganglion blocking agent is on theoretical grounds unlikely to be of much service

in controlling the rise in blood pressure which occurs. Indeed tetra-ethyl ammonium bromide may actually precipitate a hypertensive crisis. Specific adrenergic blockers must be used. For this purpose Regitin (13), which can be given by intravenous drip, is probably to be preferred. It is possible that this form of hypotension might be adopted for use in other fields of surgery too, for it is said to be reversible by nor-adrenaline. Secondly, some preliminary work of promise has been carried out on the administration of Serpasil (14). It has been found that a patient under the influence of this drug has a vasomotor system which is somewhat unstable; in such cases the head-up posture used for the operation combined with the effect of anaesthesia on the vasomotor stability may result in hypotension. Even when the blood pressure is normal at first, a relatively small blood loss will often induce a degree of hypotension sufficient to reduce markedly the amount of haemorrhage during major intracranial surgery, although no attempt has been made to produce the extreme hypotension required for aneurysm operations by this method. Lastly, and I mention this as a curiosity, it is at least possible to induce adequate hypotension by amyl nitrite given by inhalation. I have not followed up this work because the hypotension induced was so evanescent and because after-headache is frequently severe in volunteers to whom this drug is given. It may be, however, that there is a use for brief hypotension of this kind in certain specialized fields of surgery, and I leave the suggestion to you for what it is worth.

In conclusion, there are several ways of inducing hypotension each with its own special value in particular cases. Probably the most certain method is total spinal anaesthesia but it carries the risk of neurological sequelae. The next best method is the administration of Arfonad by a drip technique. If hypotension is required only for a short period it may be felt that the use of a drip is too elaborate, and that the administration of a single dose of Arfonad, or even of one of the longer acting ganglion blockers, is preferable. The place of Regitin, Serpasil, and the nitrites in such work still remains to be determined.

Résumé

Pour provoquer l'hypotension, la clef du problème réside dans l'augmentation de la relation entre le système cardio-vasculaire et la masse sanguine circulante. On peut l'obtenir soit en diminuant le volume sanguin total soit en augmentant la capacité du lit vasculaire. Ces deux méthodes ont été mises à l'essai.

Quand on provoque l'hypotension par la méthode d'exsanguination, on constate une très petite marge de sécurité entre une hypotension sans danger et une hypotension trop prononcée qui serait susceptible de causer des lésions irréversibles au cœur et aux reins. D'ailleurs, cette technique d'hypotension requiert un appareillage compliqué et délicat d'entretien; de plus, la canulation de l'artère radiale, nécessaire pour un contrôle adéquat de l'hypotension, est parfois suivie de gangrène.

La deuxième méthode de provoquer l'hypotension consiste à produire une vasodilatation généralisée. Au moyen de certains agents, on peut paralyser le système vaso-moteur dans presque toute sa totalité. C'est ainsi qu'on peut produire l'hypotension en administrant du chlorpromazine qui déprime les

fonctions des centres hypothalamiques et possède également une action sur la moëlle à l'égal d'agents analgésiques comme la morphine et le Démérol. On obtient une hypotension plus complète, cependant, par le blocage périphérique du système vaso-moteur. Pour y parvenir, on peut employer la technique de la rachianesthésie totale, mise à point par Gillies, ou cette méthode plus populaire qui consiste à bloquer les ganglions de la chaîne sympathique par des agents tels que l'hexaméthonium et l'Arfonad. Voici la technique d'administration de l'hexaméthonium telle que préconisée par l'auteur: on donne une première dose de 20 mg. suivie d'une deuxième, 10 minutes plus tard, qui varie de 90 à 100 mg. suivant la chute de la pression artérielle entrainée par la dose initiale.

L'Arfonad est un agent beaucoup plus puissant et plus sûr que l'hexaméthonium; on l'administre par voie I.V., dans un sérum salé, en goutte à goutte, à une concentration qui varie de 0.5 à 1.5 mg. par cc., suivant la susceptibilité anticipée du patient à l'égard de cet agent. Une tachyphylaxie à l'Arfonad peut se produire. L'Arfonad est rapidement détruit dans l'organisme.

Chez des patients qui résistent à l'action de l'Arfonad ou de l'hexaméthonium, l'administration d'une plus grande quantité d'anesthésiques généraux ou l'abstention de donner une transfusion sanguine peuvent aggraver l'hypotension.

On peut employer la Régitine pour contrôler l'hypertension qui se produit au cours des opérations pour phéochromocytomes. On a déjà fait certains travaux préliminaires sur l'emploi du Serpasil.

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ADVANTAGES OF INDUCED HYPOTENSION*

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THE TOPIC "Advantages" would have been easier to discuss if this were 1950, rather than 1955, as everyone was much more enthusiastic, and almost eulogistic in some cases, about induced hypotension. In the interim, there have been various suggestions about complications of the technique, but no paper has been more horrifying, from a statistical viewpoint, than that of Little (1), containing the results of the Yale University survey on induced hypotension in Great Britain and America. I might even say, as I am sure many anaesthetists do, that there are no advantages in using induced hypotension.

However bad the statistics on morbidity (1 in 31) and mortality (1 in 291) reported in the above survey, I do not think we should be stampeded into an outright condemnation of the technique. I should like to suggest that there has been a little over-exuberance in the use of hypotension. Oddly enough, very little outward exuberance is shown in Edinburgh where the clinical use of induced hypotension was first, and still is, practised. Dr. John Gillies (2) points out that inexperience and lack of knowledge of physiology are the main contra-indications to the use of the technique, and now holds short courses, didactic and clinical, for the interested visitors.

Having been assigned the topic "Advantages," then, I must consider the question: Are there really any advantages? I should like to distinguish between advantage and indication. According to the Oxford Dictionary, advantage means "a stronger position, superiority, gain, favourable circumstance." Indication stands for "something pointed out, made known, shown, or be a sign of." The former implies a benefit to the patient, but not necessarily the latter. Induced hypotension, in most instances, increases the hazards of surgery, and there must be some definite justification to have the patient run this calculated risk.

My personal experience with induced hypotension is with a relatively small series of cases, as shown in Table I. However small the series is, all patients have been selected as to suitability to withstand hypotension; for example, under 60 years of age, haemoglobin above 75 per cent, and free from cardiovascular disease and hypovolemia. From this series, containing a reasonably wide range of case types, I should like to draw my conclusions as to the advantages, and what type of case might be suitable for induced hypotension.

NEUROSURGERY

I doubt whether induced hypotension ever prevented death, although the converse is certainly true. However, there are certain neurosurgical operations

*From a Round Table discussion on "What is the Place of Induced Hypotension in Anaesthesia?" under the direction of Dr. Wesley Bourne, held at the Annual Meeting of the Canadian Anaesthetists' Society in the Banting Institute of the University of Toronto, June 20, 21, and 22, 1955.

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TABLE I

INDUCED HYPOTENSION, 1952–5

Cases					
Intracranial–			Plastic		14
Aneurysms	25		Neck Dissections		11
Tumours	11		Bone and Joint		8
A. V. Malform	5		Thoracic		6
		41	Breast		6
Pelvic		19	Gland Dissections		3
Abdominal		17	Parathyroid		2
Spine and Back		16	E.N.T.		2
Thyroid		15	Sympathectomy		2
			TOTAL		173
Method					
1. Ganglion Blocking Drugs: C6 (Hexamethonium)					113
Arfonad					46
2. Total Spinal (1/400 Nupercaine)					14
			TOTAL		173

where induced hypotension has been of definite value and helped to increase the survival rate. In the opinion of the neurosurgeons of this centre, the direct approach on a cerebral aneurysm, and clipping or ligaturing its neck, is technically possible only under induced hypotension. The surgical treatment of berry aneurysms, with or without subarachoid haemorrhage, in the acute stage, has been disappointing in all centres, with no appreciable change in the mortality rate as compared to conservative medical treatment (about 50–1). The opinion here, although based on only 25 cases under induced hypotension, is that the salvage rate has been definitely increased. This view is also held by Olivecrona (3) in Stockholm. It is felt that hypotension from the time the dura is opened allows an approach onto the aneurysm, with a much reduced brain tension, requiring less brain traction, with less risk of rupture. Under hypotension, if bleeding occurs from the aneurysm, it is of less force and magnitude and is more easily controlled, allowing the operator to place a clip accurately without damaging surrounding important nervous or vascular structures. At present, we have gone one step further, and now operate on cerebral aneurysms, no matter in what condition they are, under induced hypothermia with or without induced hypotension, with positive control of bleeding by compression of carotids and vertebrals, previously exposed, if necessary.

Induced hypotension has a definite place in the excision of arteriovenous malformations, and the highly vascular cerebral tumours. In both these cases, bleeding can be extremely profuse and even fatal, and proper excision can be hampered by a blood-filled field.

REGIONAL DISSECTIONS AND TISSUE DIFFERENTIATION

The best example of induced hypotension being an advantage in tissue differentiation in anatomical dissections, is exploration of the neck for a parathyroid

adenoma. The parathyroid glands are often hard to find, but with a dry field and in the absence of oozing, they can be differentiated from the thyroid by colour.

If your surgeons believe in widespread excision of organs, and dissection of regional glands for cancer—for example, radical mastectomy with dissection of axilla, pelvic exenteraction, Wertheim hysterectomy—then induced hypotension may be of considerable value in allowing the surgeon to differentiate important structures and do a safer and wider dissection.

Induced hypotension has been widely used and acclaimed in orthopaedic, plastic, and E.N.T. surgery. The advantages are said to be reduction in blood loss, protection of the patient from traumatic surgery, and a smoother post-operative course. To use induced hypotension purely to conserve blood, is, I believe, wrong, for the risks are too great to justify its use on that basis alone. With the above-mentioned exceptions, there is no operation, done by a reasonably skilled and careful surgeon, where blood conservation by induced hypotension should be resorted to. If the argument is used that the patient has a low blood volume to start with, and induced hypotension is used to conserve what he has, then one is just asking for trouble, because of the lack of knowledge of basic physiological principles.

Orthopaedic surgery on limbs is usually done with a tourniquet, and hip, shoulder, and spine procedures are done under advantageous positions for blood drainage away from the operative site. Plastic surgery and E.N.T. procedures, such as fenestration, can be done just as easily, and are probably safer with judicious use of dilute adrenaline infiltration.

This paper may sound overly conservative to some, but, nevertheless, induced hypotension requires considerable respect in its use. We must be always aware of the hazards and recognize the limited indications, and, in the final analysis, we must remember that operative results and the well-being of patients were just as good, with few exceptions, before the use of induced hypotension as with it.

Résumé

L'emploi de l'hypotension contrôlée a soulevé un enthousiasme un peu surprenant mais, en dépit des statistiques de morbidité (1 sur 31) et de mortalité (1 sur 291) (1), je ne crois pas qu'on doive condamner d'emblée cette technique. Le Docteur John Gillies (2) d'Edimbourg émet l'opinion que le manque d'expérience et le manque de connaissance en physiologie sont les principales contrindications à l'emploi de cette technique. Dans la plupart des cas, l'hypotension contrôlée augmente les risques de la chirurgie et il faut des raisons bien précises pour faire encourir au malade ce risque additionnel. Le groupe de cas du tableau no. 1 permet à l'auteur de nous exposer les avantages de cette méthode et de nous faire part de son expérience personnelle.

L'hypotension contrôlée a augmenté les chances de succès dans les cas d'anévrysmes cérébraux. Elle a également une place bien choisie dans les opérations de certaines anomalies artério-veineuses et de certaines tumeurs cérébrales très vascularisées.

L'hypotension peut également devenir très utile pour faire une dissection fine et aider à différentier des structures importantes. Un champ opératoire exsangue facilite le travail du chirurgien et l'identification des tissus. Il n'est pas admissible de pratiquer l'hypotension dans le seul but de diminuer les pertes sanguines, car les risques qu'elle entraîne ne justifient pas son emploi pour cette seule raison.

Il faut être au courant des risques de l'hypotension contrôlée et savoir reconnaître ses indications précises. Il faut bien nous rappeler, en dernière analyse, que les résultats opératoires, à quelques exceptions près, aussi bien que l'évolution des malades étaient aussi satisfaisants avant l'arrivée de l'hypotension que depuis sa venue.

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THE DISADVANTAGES OF HYPOTENSIVE ANAESTHESIA*

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THE PROBLEMS involved when studying alterations of blood pressure are innummerable and many of the present ideas on the subject are questionable.

When considering hypotension it first appears there is marked disagreement among medical men as to the influence of periods of lowered blood pressure on the well-being of a patient. Secondly, it is not clear whether the systolic, the diastolic, or the mean pulse pressure reading is the most significant value. And thirdly, if a patient's usual blood pressure is to be taken as optimal it is not decided under what conditions or period of time it should be recorded to be reliable.

While forming my opinion of hypotensive anaesthesia I have been influenced by the difficulties which have occurred during the conduct of my own cases and by the views expressed in the literature. I shall try to show briefly from these two sources the importance of the disadvantages.

In my own experience I have been singularly unsuccessful in producing a totally bloodless field. I have also the impression that, provided a properly sedated patient is induced very smoothly, minimal elevation of blood pCO_2 is permitted, and smooth anaesthesia is maintained through a perfect airway, the bleeding will not vary greatly from that which will occur during safe induced hypotension, provided the surgery is efficient.

I apologize for giving my impressions of this fact but I have been able to find little statistical proof that measured blood loss can be greatly reduced in comparable series of cases.

Recently Griffith (1) has shown that the bleeding time as estimated by the "Modified Ivy" technique is equally prolonged by general anaesthesia or a systolic blood pressure between 65–80 mm. Hg.

Shackman and his co-workers (2) believe that skin and muscle blood flow during maintenance of general anaesthesia is virtually unchanged despite a 45 per cent reduction of mean arterial pressure.

It is agreed that the normal clotting mechanism may operate satisfactorily in the dilated vessels because of the low head of pressure but there is no support for the view that a surgical incision will lose less blood from small paralysed vessels unless extreme posture is used. The larger vessels should be controlled by classical means always—if not, reactionary haemorrhage is inevitable.

It is possible that I have been less successful in my cases because an undue number of patients have been resistant to the blocking agents, or a majority may have had a blood dyscrasia of minor nature which gave rise to the

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"bleeder," or my patients have been exposed to one of the many bad influences on capillary fragility; but we must all come across such patients and hypotension is then of little help. For safety, it is essential that a full circulating 100 per cent volume of blood and 100 per cent oxygenation be maintained; it is very hard to obtain such perfection and the lower the blood pressure the less is the margin of safety. As we have heard, the controllability of many of the described methods is not simple: they necessitate much experience and entail some strain on all but the most imperturbable anaesthetist.

We are still unable to ascertain blood volume quickly and correctly as a routine, and too few centres accurately measure blood loss. Yet this is essential if the dire result of inadequate replacement is to be avoided. It has been said that, provided the venous pressure is maintained, there is little danger—whenever I have recorded venous pressure it has been reduced with the arterial pressure.

If the use of hypotension is avoided in unsuitable conditions, particularly during uncontrolled haemorrhage, one is often faced with a request by the surgeon merely to take the head off the pressure. This is not only dangerous but can be futile as it may aggravate the bleeding, owing, presumably, to the presence of relaxed vessels within which there is still considerable pressure.

On the rare occasions when it is thought desirable to use hypotension to make the impossible possible it is often ruled out for one reason or another. For instance, no essential organ or tissue which is impaired should be exposed to further strain, so that any gross pathology of brain, heart, liver, or kidneys must exclude its use; as the operation site should be elevated, it is unsuitable for some operations; it seems unwise to maintain the hypotensive state for very long periods of time even when possible; the very old or the very young are poor subjects; the anxious youth or thyrotoxic patient, undoubtedly owing to their excess of endogenous adrenaline, are most resistant; the foetal anoxia which would result excludes its use during pregnancy; the diabetic is subject to an hypoglycaemic response to insulin if hexamethonium is given because the compensatory sympatho-adrenal discharge is prevented.

These are some of the practical difficulties involved in the application of the technique and I shall now review some of the reports of the outcome of its use.

The Yale University report (3) of the sequelae which occurred when hypotensive anaesthesia was employed in 27,930 operations, disclosed the appalling over-all mortality of 1/291 with complications in 1/.31 cases. This unbiased analysis was compiled from questionnaires returned by 464 specialist anaesthetists.

It is generally agreed that hypovolaemic hypotension with the associated reduced cardiac output, intense peripheral constriction, and plasma skimming will give rise to hypoxia. Investigations centred around normevolaemic hypotension are more conflicting.

During hypotension, despite a decrease of the cerebrovascular resistance, there seems to be a reduced blood flow to the brain but owing to an increased oxygen uptake compensation may be adequate in the anaesthetized patient. Even when anoxia is avoided, however, thrombosis with subsequent embolism

is an ever-present danger whenever circulation is so reduced. As the general circulation time is increased whatever the degree of hypotension, this danger applies to all parts of the body.

When hypotension is induced, cerebrospinal fluid is decreased and the brain shrinks and changes its consistency; the resultant soft dough is easily compressed and slow to regain its normal conformity. This leads to so-called "retractor" anaemia which can cause widespread damage and be followed by oedema or thrombosis.

Other reports of the electroencephalography, flicker fusion tests, retinal changes, etc., are not complete enough to be conclusive. Likewise, electrocardiographic changes are not constant but tend to incriminate the procedure by the frequency with which tracings resembling those due to anoxia occur. Myocardial infarction must be an ever-present danger as coronary disease can occur in young, apparently healthy patients. If the occlusion occurs gradually over a period of months or years, with the concomitant development of anastomotic circulation, the condition is clinically undiagnosable, but clearly the coronary reserve is reduced. Since oxygen extraction by heart muscle is almost maximal, it is nearly as vulnerable as the brain.

The renal haemodynamic response to blood pressure reduction leads to a fall in filtration rate with temporary anuria at 50–70 mm. Hg. level and some hypotensive agents are known to be eliminated unchanged only in the urine. Thus a precipitation of uraemia and prolonged hypotension can occur respectively.

Investigation of the effects of hypotension upon the liver has not yet been properly reported.

If the parasympathetic system is blocked, gastric motility and emptying are impaired and cases of distention and ileus are reported. I reflect that the present method of anaesthesia recommended for cardiac surgery leaves the sympathetic system in the most responsive state to counteract any insult; my experience of severe stimulation applied to patients without a functioning autonomic system has been most disturbing.

To apply controlled hypotension safely it has been said that anaesthetists of physiological outlook and great skill are required before, during, and after the operation, but I am still unconvinced that they can regularly in this way provide the best operation conditions or avoid considerable risk to every patient.

These techniques are of great interest and can be applied to many other fields, so it is imperative to experiment more in the hope that some day we can control the blood pressure with as little obvious upset as occurs when we now control respiration.

Résumé

Les problèmes suscités par l'étude des différentes altérations de la pression sanguine sont incalculables et plusieurs des idées actuelles sur le sujet sont aptes à être étudiées.

Il existe un désaccord marqué dans le monde médical au sujet de l'influence des épisodes d'hypotension sur l'état général du malade et il n'y a rien de précis

à savoir si la pression systolique, la diastolique ou la pression sanguine moyenne est la plus importante. Si la pression sanguine habituelle d'un sujet est considérée comme "idéale," il est à se demander dans quelles conditions elle sera considérée comme "fiable."

Selon l'auteur, pourvu que l'anesthésie soit donnée "avec douceur" et que l'élévation du pCO^2 sanguin soit maintenue au minimum, la perte de sang ne sera pas plus considérable que celle qui serait observée si l'hypotension avait été amorcée, ceci au cours d'une intervention chirurgicale adéquate. Griffith (1) et Shackman (2) ont publié des notes intéressantes sur ce sujet. Le mécanisme normal de coagulation fonctionnant de façon satisfaisante dans les vaisseaux dilatés, il n'y a rien qui laisse prévoir qu'une incision chirurgicale entrainera moins de pertes sanguines à moins d'être en face de positions favorisant la stase.

Pour être du côté "sécurité" quand il s'agit d'hypotension, il est essentiel qu'un volume sanguin circulant total et une oxygénation adéquate soient maintenus. Nous sommes encore incapables, de routine, de contrôler rapidement un volume sanguin et trop peu de centres mesurent les pertes sanguines. Les organes essentiels qui sont souvent le site de troubles importants ne devraient pas être soumis à cette nouvelle épreuve: l'hypotension. Dans de rares occasions où il serait désirable d'employer l'hypotension pour rendre possible l'impossible elle est souvent contre indiquée pour une raison ou pour une autre.

Le rapport de l'Université Yale sur les séquelles de l'anesthésie avec hypotension révèle un nombre terrifiant de morbidité et de mortalité associées à cette technique.

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PANEL DISCUSSION OF QUESTIONS SUBMITTED AT THE CLOSING SESSION OF THE ANNUAL MEETING OF THE CANADIAN ANAESTHETISTS' SOCIETY JUNE 23, 1955

Chairman: Dr. B. C. LEECH, O.B.E., M.D., C.M., F.F.A.R.C.S.

THE PANEL as we propose to present it is quite a departure from ordinary panel or Round Table discussion techniques, in that I am throwing these experts to you to be sniped at, all ten of them, from any angle you wish in the whole field of Anaesthesia. That is quite unusual and a new departure, I think, in panel discussions. It has been suggested that we try this once, and see if it is advisable at the end of a two- or three-day conference in order to help clear up any misunderstanding that might exist in reference to the papers which have been presented, or some question that you came prepared to get an answer to, and which unfortunately was not dealt with during the course of the convention. The members of our panel include five from the United Kingdom, and five from Canada; among them we have a lady from each side of the Atlantic. I shall introduce them, and I wish they would stand so that you can remember well who they are, as I call their names. First those from the United Kingdom: Dr. Sheila Anderson of London, interested in paediatric and neurosurgery anaesthesia. Dr. R. W. Cope of London—he is particularly interested in paediatric and acute abdominal work; Dr. Langton Hewer of London—if you try the D.A. examination sometime in London you will certainly meet him; Dr. Geoffrey Organe, whom you have already met I am sure; Sir Robert Macintosh the Professor of Anaesthetics at Oxford University. And now the Canadian members: Dr. Donalda Huggins of Winnipeg, Chief of the Department at Winnipeg General Hospital, and Senior Teacher at the University of Manitoba Medical School; Dr. Ted Gain of Edmonton, Head of the Department of Anaesthesia of the University of Alberta; Dr. R. A. Gordon of Toronto who needs no introduction to any of us; Dr. Gordon Wyant, Professor of Anaesthesia, University of Saskatchewan; and Dr. Léon Longtin, University of Montreal.

We have a whole sheaf of questions which we shall try to cover well within the hour allowed to us. Some of these I have put names on, and some of the panel members have agreed as I have designated their questions. Others have objected: many questions they have never seen before, and questions have been arriving until 2:00 o'clock today. I hope to start out with something we can cover rather quickly, and thus get into the swing of things. I would request that any comments from the floor be held until the whole panel is over because your point may be covered by the next speaker.

Let us start off with Dr. Organe and Dr. Gordon, and ask them some of the questions which have been submitted.

QUESTION 1

"What proofs are there that muscle relaxant drugs do not pass a placental barrier in sufficient concentration to affect the foetus which will be delivered either by Caesarean or per vagina within fifteen minutes?"

DR. ORGANE: While I will not talk of any proof, experimental work has been done, particularly on the rabbit foetus and it shows, as I think, that as far as that work went, no significant amounts passed the placental barrier. Since relaxants came in, at least since this animal work was done, I have used muscle relaxants in all Caesarean sections, and my impression has been not that the infant has been in any way weakened by muscle relaxants, but that owing to the very much lighter anaesthesia which we have been able to use with the aid of muscle relaxants, the children have breathed more quickly and have been more vigorous afterwards than they have been with ordinary general anaesthesia; to my mind, on clinical grounds at any rate, using minimal quantities of muscle relaxants, there is no evidence at all that the child is in anyway affected by any of the muscle relaxants.

DR. GORDON. Mr. Chairman, I might say that this is a surprise to me because I said I could not answer this the last time I talked to you. I gather that the question means absolute proof in the matter of the passage of muscle relaxants through the placenta. There is in fact, I think, pretty fair proof that muscle relaxants do pass through the placental barrier and that the question of whether or not they are detrimental to the foetus depends on the concentration which the infant receives. There has been work reported from the University of Iowa, which Professor Lucien Morris discussed at the meeting of the Canadian Anaesthetists' Society two years ago, and those of you who were there at that time may recall that the point of the matter was that the muscle relaxants could be identified in the placental circulation after being given intravenously to the mother, but that no significant concentration had been demonstrated except in cases where it was injected into the uterine artery, which of course is quite an impractical procedure in clinical anaesthesia.

QUESTION 2

DR. LEECH: Here is a question from an obstetrician:

> "What method of anaesthesia is advised as the best for the ante-partum external version manipulation when the presenting part is engaged?"

Dr. Cope, can you start us off on that?

DR. COPE. I think so, Sir, but my answer will be a brief one. I think the method is Chloroform, in one word.

PROFESSOR MACINTOSH. Well I don't know whether it is because one has become a little more bald-headed than Senior, but I don't think I have been called in for an external version when a part has already presented.

DR. LEECH. Engaged, Sir.

PROFESSOR MACINTOSH. Yes, I am just wondering whether, on the question of the ordinary external version, a tip is worth passing on that you don't know about. Some, of course, are extremely easy, and some impossible; but in between there is the patient who has the combination of a tight uterus and a tight abdominal wall, and we have found effective what we would call a small dose of Pentothal (that is anything up to half a gram) to relax the uterus, and a full dose of relaxant for the abdominal wall. I notice my colleague here from England talked about minimal dose of relaxants. In America that is 2 or 3 mg.

of Curare. I think Dr. Geoffrey Organe had in mind 15 or 20 mgm. Certainly in talking about versions I have doses of that magnitude in mind.

DR. LEECH: Sir Robert, I forgot that you had asked to speak on the former question. Would you like to add anything to Dr. Organe's or Dr. Gordon's remarks concerning the relaxant drugs passing the placenta?

PROFESSOR MACINTOSH. I did that very thing, Sir, when I told Dr. Organe that I think that "minimal" doses of Pentothal and Curare vary greatly with the country from which you come. When I was in New York there was a bit of discussion there whether fifteen or twenty mg. of Succinyl Choline should be given, and I said why not give 100 as everyone does. They thought that that was too bad. The same applies, I think, to Curare. The other point of the question concerned proof. It is a funny thing that I have not had Curare blamed for depression of the foetus; and I know that in our group of hospitals we have been using the relaxants for ten years for Caesarean section, as far as we know with satisfaction, and no blame for anything has attached to it.

QUESTION 3

"List the requirements for efficient cardiac massage."

DR. GORDON WYANT. Well, there must be some idea implied that I am a particular specialist in cardiac massage. I hope I am not. I believe that there are two essential criteria for efficient cardiac massage; you must be able to obtain an adequate blood pressure and pulse. You remember that cardiac massage is carried out with the purpose in mind of restoring the oxygen-carrying system by artificial regulation of the circulation. Therefore we must be able to be sure that it *is* efficient; the peripheral pulse must therefore be felt and blood pressure should be found obtainable.

DR. LEECH. Anything short of that you have stated would be inefficient?

DR. WYANT. That is correct.

DR. ORGANE. Like Dr. Wyant I disclaim any experience in this, because I am actually inexperienced. But from what I have read in text-books, I have taught that cardiac massage should be carried out at a fairly slow rate, because with no back pressure in the veins it takes some time for the auricles to fill and for the ventricles to fill, in order that the next pulse wave that goes out should contain a reasonable amount of blood. But on the one occasion when I did myself do some cardiac massage, the child died under anaesthesia for tonsil operation. After some time it was quite evident that the child would not live so we tried cardiac massage. I was surprised how easily it was possible to obtain quite an efficient artificial circulation. We continued artificial respiration with oxygen and if the massage was carried out inefficiently or stopped for a while everything would go blue, but you could even get the fingernails pink comparatively easily by doing cardiac massage; the man who was most efficient at this was the man who was doing the massage at a rate of about 80 times per minute. This was a child, and it may be that in a child a rapid rate is more appropriate than in an adult. I do not know. What I do know is that after a prolonged period of cardiac massage the heart was grossly damaged.

DR. DONALDA HUGGINS. I think one of the requirements is making a diagnosis. You can massage the heart all you like without success if you have missed the time when it was going to do any good. I think that one should always be alert and ready, watching for cardiac arrest, and have the equipment in the room to do cardiac massage. I should like to divide it into three minutes, and let each minute have some particular part to play in the successful outcome. I think each person in the operating room also has a part to play. One nurse should be assigned to count off the seconds, five, ten, fifteen, because often when such an emergency occurs everyone forgets the passing of time. Another thing is to have cardiac massage (thoracotomy) equipment available readily. Thirdly, the anaesthetist, if he is with an otolaryngologist certainly will many times have to take over the massage or the supportive measures, and so he must remember that the minutes are passing. If he has to pass over the oxygenation of the patient to someone else and do the thoracotomy and cardiac massage himself, he must have the assistant available to take over the massage also, because your hands get very tired massaging a heart through a chest wall.

QUESTION 4

DR. LEECH. Now a question on the same subject:

"What should be accepted as the safe and sound criteria for abandoning further resuscitative measures in a case of cardiac arrest?"

I feel that this is an important question and deserves an important answer, and one which could well make medical-legal history. I have asked Dr. Hewer to give us the first answer.

DR. HEWER. While I don't want to make medical-legal history on this subject, a lot of the points, I think, have been covered by the previous speakers. The essential time, it seems to me, is before the cardiac massage starts. The cells of the cerebral cortex have only a very limited period when they remain viable with no circulation, and that is the essential time limit. You could go on doing cardiac massage for months if you have exceeded that time limit and the patient will never recover. He may become a sort of a decerebrate animal and get reflexes back, but that isn't much good. There is one point regarding the actual doing of the cardiac massage which hasn't been mentioned: that is, that a good deal of work has been done on the subject showing that the essential feature of the cardiac massage is the maintenance of pressure in the coronary arteries. If you can raise the coronary pressure the heart will probably start, and you can raise that pressure very considerably if it is possible to squeeze the aorta at the same time as the cardiac massage is done. Now that is probably impossible if you are doing the cardiac massage through the diaphragm, but if the chest wall is open, then I think it is well worth getting an assistant to put a good deal of pressure on the aorta while the cardiac massage is being done. Then the coronary pressure will rise and you have much more chance of starting the heart. You will see I have very skilfully avoided this issue. I haven't said anything about limiting criteria, but I have thought that while there is evidence of an efficient artificial circulation it is worth going on. If the mucous membranes are pink, if

pressure on them produces blotching which disappears on removal of pressure, I would think it is worth continuing cardiac massage—but the minute this stops I think it is quite useless to go on. I do not think that one can possibly give a time limit. To start with, why did the heart stop in the first place? It may be due to all sorts of things. It may be due to exsanguination and if that is the factor which has caused the heart to stop, it has to be removed. It may be a reflex effect, with chloroform or adrenalin or something of that sort. I do not think it is possible to give a time limit, but I would suggest that the criteria should be clinical as I have tried to indicate.

DR. LÉON LONGTIN. To give specific criteria is very hard in my opinion. Time lapse since the heart stopped is not a criterium, because there are cases reported of recovery after thirty or forty minutes of massage or resuscitation measures. Perhaps dilatation of the pupils would be a criterium, but this must be correlated with the drug the patient received before and the depth of anaesthesia. The consistency of ocular globes may be one criterium. About one year ago I had a case that was already surgically completed, and suddenly when taking the blood pressure I realized there was no blood pressure or pulse. I had the surgeon who was operating check the pulse, but there was none. We started cardiac massage right away. In the meantime the patient was still breathing and he kept on breathing. We gave him some blood. The thing went on for about forty-five minutes. The heart was then massaged but as soon as this was stopped the beats were slower and slower and the heart would stop again. We did this for four hours, and the patient was breathing all the time. The surgeon was getting tired, and asked, "when are we going to stop?" I told him we could not stop, because this patient was not dead and was still breathing. We kept on like this for ten hours. The patient died after ten hours, and the post-mortem revealed that this patient had a cardiac infarction twenty-four hours before operation. It was almost impossible to live with such important damage.

DR. LEECH. Sir Robert, can you help us on this?

PROFESSOR MACINTOSH. I would have suggested in this last case of Professor Longtin's that there must have been some circulation for the man to continue breathing. I know even Koster in the old days of spinal anaesthesia had many patients on whom he couldn't record a blood pressure, the spinals went very high. When his attention was drawn to that he said "It's all right I can feel some beat in the aorta"; so we can survive with extraordinary low pressures. As far as answering this question specifically I don't suppose there can be any precise answer. I think most people today are quite satisfied when they come up to a person whether he is dead or not, and yet in the old days I can remember lots of people who used to leave money in their wills for the doctor to cut the artery to make sure they were dead before they were buried, and I have a letter from an old man in Vienna who tells me that in the post-mortem room there they used to have a rope that they tied around the corpse's hand at night in case he woke up; it would appear that in those days certain people (whether due to inferior medicine or not) were certified as dead when they were not. Certainly when I have seen cardiac massage carried out it has always been carried out for many minutes after one has felt that the thing was completelv

hopeless. I would have differentiated as Dr. Hewer does on the cause of the arrest. I should think if anyone dies from Pentothal, ether, or Cyclopropane as they did in the old days, then any massage longer than a few minutes was doomed to hopelessness. But on the other hand I do know of a heart being operated on, and when, very likely owing to surgical manipulation, the heart stopped, cardiac massage was carried out for twenty minutes and the patient recovered. The very striking thing is that in this case massage was very efficient because the boy made a completely uninterrupted recovery and was discharged at the usual time; but the circumstances were ideal because the pericardium was already open and skilled people were at hand.

DR. LEECH. Dr. Hewer and Professor Macintosh have each indicated that as long as efficient circulation can be maintained the case should not be abandoned. I wonder if we could describe what might be considered efficient? We heard a description of efficient cardiac massage previously. I would suggest that if our efforts at cardiac massage cannot produce a palpable pulse either in the radial artery or in the neck vessels something has happened, and I think that what must have happened is that the heart is no longer filling, and therefore you cannot get any blood out of it. I think perhaps that this question might be quite acceptably answered on that basis: If the heart no longer fills, nor can be made to fill by slowing up our timing a little, that we are then quite justified in abandonment. I think that would be acceptable to medical-legal authority if it receives general support. Do you think such a definition would bear medical legal support in England, Professor Macintosh?

PROFESSOR MACINTOSH. The only thing is that I don't know how you are to tell when the heart is filling. I know the cardiac massage can be effective. I know a patient who died under "secondary saturation" in one of the services, and he was inflated with oxygen and of course nothing happened; then when the surgeon started cardiac massage he became a beautiful colour, but it was quite ineffective. I just don't know, Sir, what criterium you are going to take for the heart filling. Would the panel like to express themselves?

DR. LONGTIN. Yes, I should like to ask the Chairman to have Dr. Vandewater tell us the story of a patient they call "Lazarus."

DR. LEECH. Can we reserve that for the cocktail party?

DR. LONGTIN. Yes.

QUESTION 5

DR. LEECH. To change the subject now, we have a question with a little spike of military in it.

> "Much as we dread the thought, another great war in our time is considered a distinct possibility. As anaesthetists, how should we be thinking, planning and teaching in preparation for anaesthesia services both military and civil?"

I should like to ask Dr. Gordon to commence this because I know he was adviser to the Director General Medical Services (Canada) on table for anaesthetic equipment and so on. I think he can start us off very nicely.

DR. GORDON. Mr. Chairman, this is a very large question. This problem has been dealt with in part in this meeting by three or four speakers, and I think that the answer will resolve itself into three parts. First is the provision of personnel, who are adequately trained to cope with the anaesthetic problems in disaster situations, whether they be civil or military. The second part concerns equipment and the type of equipment which they would expect to use, or which they may expect to have. The third is related to the problem of supply under disaster circumstances. As far as personnel are concerned, I believe that Dr. Gain's theme in his paper yesterday in dealing with anaesthetic deaths in the Province of Alberta, that every doctor should be trained to a state of competence to do simple anaesthesia, is the most important fact to remember. As far as disaster situations in the civil population are concerned, that training may be of the utmost importance. We all know that our trained anaesthetists are likely to be concentrated in larger hospitals or in the hospitals of an area where disaster strikes us. Very few of them may survive the first blow and it is quite evident that someone else must carry on. It may even be evident if we think a little farther that some of these people with a minimum of training will have to carry on with lay assistants. For that reason the question of equipment is very important. Most of these people will not be adequately trained to deal with elaborate anaesthetic techniques. Professor Macintosh this morning brought this home to us in his discussion on simplicity in anaesthesia. I am not sure whether we can count on them having as pretty a piece of apparatus, Sir Robert, as this beautiful vaporizer and ventilating equipment you have shown us. I am quite sure most such equipment will be found stored in hospitals and will likely not be available when it is most required. I think that in these people who may be responsible for carrying on the anaesthetic services to a population involved in a disaster the faculty of improvization is most important. We all know of people who must have an endotracheal tube, who insist on a Charles King No. 10 Magill before it would be considered an endotracheal tube, when in fact there may be lots of rubber tubing around which will serve the same purpose if it is essential for this to be used. The same thing holds for ether vaporizers. An old tin can out of the neighbouring garbage pail may be converted into an ether vaporizer if this should be necessary. I think we must teach our medical population to recognize first the danger signs in anaesthesia. I don't know how far we could go in teaching elaborate methods of getting out of trouble when trouble occurs, because in these situations it is probable that most of them won't get out of the trouble anyway. I am not sure that the better attitude is not to teach people to recognize danger and at that point to desist, and wait until things correct themselves. The question of supply is a double problem of availability and transport. That occurs in military situations. It may not occur in the R.A.F., Sir, or it may not occur in the Navy—they take all sorts of things along with them. I think there may be some people in this room who were in Italy and found that when General Montgomery wanted shells transported, oxygen, nitrous oxide, and such things didn't matter a bit, and you could work with your bare hands for all that that mattered. I think we must go back to consider the use of agents which are likely to be transported in small space, which won't involve great weight, in transport, and which are likely

to be obtainable from mixed sources; and although I am sure that are some people who will shudder at the suggestion, and Dr. Jarman may be one of them, I think that we will have to rely on ether and perhaps chloroform if we can find it. Certainly I think that ether is likely to be the most readily available anaesthetic agent in these situations. I think, Mr. Chairman, that is all I will say on this problem, I have used up more than my time.

DR. LEECH. Thank you, Dr. Gordon.

DR. LEECH. Dr. Cope has some connection with the R.A.F., I believe. Can you help us on this?

DR. COPE. Mr. Chairman, my connection was not with the R.A.F. but the Army Medical Services in the R.A.M.C., and what I can add is based on that experience of some years ago. Two points I should like to make, both of them to reinforce very sincerely Dr. Gordon's remarks. First about personnel—these remarks are made solely with regard to the Armed Forces in the field. I think that it is essential not to put your most junior trained anaesthetists or surgeons in field units; a very high portion of trained surgeons and trained anaesthetists were put into units called Field Surgical Units grouped around a larger unit first called a Casualty Clearing Station and then the Advanced Dressing Station. To think that because a man is young he is the most fit and is therefore the man to send forward may very well jeopardize the chances of survival in your massive or major battle casualties. They need surgical judgment and experience based on ordinary civilian experience coupled with the necessary technical skill. This, I think, applies very strongly to anaesthetists who are, at the same time, just as in civilian practice, partially resuscitation officers. So don't send your junior men forward, keep them under training and getting more experience with some skilled people in general hospitals. As regards equipment, again I reinforce almost entirely what Dr. Gordon says: simplicity, I believe, above everything. I think that the greatest simplicity is a couple of syringes, some Pentothal, and if possible a supply of relaxants and some means of inflation. In the last war, Professor Macintosh produced a beautiful piece of apparatus for anaesthesia called the Black Kettle, sometimes called the Oxford Vaporizer, and we used it, of course with ether, and found it a great God-sent blessing (despite some accidents when you tipped it up and threw it about during transport causing seepage of calcium chloride within the apparatus, which fault was very quickly overcome). I can say what a wonderful type of simple robust inflator that was. I think the other bit of advice that might be given is to teach everybody that should they be advancing, they should concentrate very strongly on booty (medical and surgical equipment) as they go forward. They never know when they will have to come back again, supply channels will fade out, and I can say very truthfully that a vast number of operations in my small units were undoubtedly carried through successfully by employing booty materials until lines of supply became established.

DR. LEECH. The hospital with which I was connected in Sicily had to operate for two months completely on looted equipment. I know what you speak of, Sir.

Here is a series of questions from an American. I am going to take the liberty of stepping outside the panel because he asks some direct questions of Dr. Harold

Griffith in connection with Dr. Griffith's earlier presentation, and I am going to pass them to Dr. Griffith and let him look them over in the meantime.

Now, Dr. Langton Hewer, here is a question directed to you, Sir.

Question 6

> "Dr. Hewer's extremely interesting paper only touched, as it was intended to, on the physiology etc., of the Trendelenburg position. Would the panel please discuss the necessity for the position beyond say 10 or 15 degrees? With good modern anaesthesia, good relaxation, etc., is it really necessary?"

Dr. Hewer. Well I think myself that it is better not to have Trendelenburg position at all, but if you have to have it, have it as mild as possible and for as short a time as possible. I don't know whether I can add much to that. I think it is perfectly ridiculous with a really good anaesthetic and relaxation. I think you might just as well say that to do a gastrectomy you have to hold the patient up by his head. I don't see really that there is any necessity to have a pelvis which is completely bare on all sides; it is not necessary at all. Careful retraction on a completely relaxed patient will give the surgeon complete access to any part of the pelvis, and, I have never myself seen the necessity for any Trendelenburg position provided, as I say, that the anaesthetic is properly given and the abdominal wall is completely relaxed. I don't think I should say any more than that, Sir.

Dr. Leech. Thank you. Is Dr. Griffith now ready to answer the questions referred to him directly?

Question 7

Dr. Griffith. The questions, Sir, deal mostly with the comparative explosion hazards between Cyclopropane and ether. I don't know that there is much difference in the explosion hazards between Cyclopropane and ether or a mixture of nitrous oxygen, oxygen and ether. They are equally dangerous if a source of ignition is in effect set off. Some of the British anaesthetists visiting the United States are extremely apprehensive concerning Cyclopropane explosions, in contrast, and not very apprehensive concerning nitrous oxide, oxygen and ether. I note that George Thomas's figures bear me out, because there are more explosions with ether than with Cyclopropane, which seem equally dangerous and in the same bracket as we enter into the situation.

Question 8

This next question concerns the so-called Cyclopropane postoperative shock and collapse in the absence of carbon dioxide build-up. Now how do you know there is an absence of CO_2 build-up? As Dr. Cullen's paper yesterday or two days ago demonstrated, there is an insidious type of CO_2 build-up that we don't know anything about, and in the great preponderance of cases ventilation hasn't been properly done; in many of these cases one does not think there is a CO_2 build-up. That, in my opinion, is very often the cause of so-called Cyclopropane

postoperative shock particularly. There is sometimes an overdosage, not of Cyclopropane, but of other agents we have used at the same time, and that is true perhaps in the postoperative excitement that we sometimes see after Cyclopropane; it may not be the Cyclopropane in itself, it may be the other agents which were given along with it, for instance in Pentothal induction and preoperative medication with morphine and other drugs.

Question 9

The next question concerns the capillary oozing in Cyclopropane anaesthesia. Sir Robert Macintosh told a very good story about that the other day. The story was, unless I forget, that a visiting surgeon was in an operating room one day, and the surgeon who was operating was very much opposed to Cyclopropane. He was complaining about the bleeding, and he made the remark, "Oh we always get a lot of bleeding with Cyclopropane." The anaesthetist said, "What did he cut now?" I do not think that Cyclopropane is really very much more apt to give oozing under proper operating conditions.

Question 10

Dr. Leech. Here is a question—I don't know whether you have to be long or short in replying:

"What place should subarachnoid block now be accorded?"

Dr. Wyant. I believe that there is a definite place for subarachnoid block. Many indications for this procedure have disappeared. The availability of the muscle relaxants is one of the arguments of the surgeon, but you cannot get as good muscle relaxation for abdominal operation as you can with subarachnoid spinal anaesthesia. Of course this is true, but there are certain procedures in which it is certainly valuable. I personally believe that certain lower abdominal procedures, say Caesarian sections, haemorrhoidectomy, and procedures of that sort, are a quite valid indication for subarachnoid anaesthesia. Of course it depends entirely whom you speak to when you ask for an opinion. Some people will say that there is absolutely no place for this block, and others will almost insist that all operations on the abdomen be done under subarachnoid spinal. I believe that the truth is somewhere in between these two extremes.

Dr. Leech. I should like Professor Macintosh to comment on that question.

Professor Macintosh. I should assert, Sir, that the place *par excellence* for a spinal anaesthetic was with the patient who dislikes to go to sleep. I think if we went around even in this roomful of anaesthetists we should find different religions, different approaches to different subjects; one great difference (surely we have all had it), is between the patient who says "I don't mind what you do with me, as long as you put me to sleep" and the other who says "the only thing I am terrified about is going to sleep." Almost the first thing I say to the patient is "Do you want to remain awake or do you want to go to sleep?" I think it is quite cowardly on our part, if a patient really is frightened of going to sleep, not to give him the spinal if it is indicated. I must encourage, then, a reasonable

approach to spinal anaesthesia. I should think that we have to differentiate between what the patient needs and what isn't very profitable for our pockets, and the great trouble is, of course, that if you give a spinal and anything goes wrong it's likely to be costly; whereas if you give Pentothal or Cyclopropane (you can't kill them with ether), then of course you can kill them with kindness, and you hear nothing about that.

[Editorial Note: This observation probably reflects the present attitude of British Coroners' Courts.]

DR. LEECH. Dr. Cope has some views on this subject.

DR. COPE. I think the question was, Sir, regarding the subarachnoid block. I think that the indications which Professor Macintosh has described are very true indeed. I think there are some strong surgical and medical reasons, such as relief of strangulated hernia in an old man with very severe bronchitis, that type of patient, and Caesarean section too. But is not the necessity for blocking far more safely met perhaps by the extradural approach either through the lumbar region or through the thoracic region? I should have thought that there was now enough evidence that occasionally—and there is no need to say when—one of those dreadful complications occurs with a spinal. I believe I am right in saying that probably can be corrected, but I have recently heard of only one extraordinary case of meningitis following extradural block, and for many years these blocks have been carried out with no evidence at all of any trouble afterwards.

QUESTION 11

"The Anaesthetic Recovery Room: Where should it take over? Where should it leave off?"

I shall ask Dr. Gain to start this one.

DR. GAIN. That was *Anaesthetic* Recovery Room. There is quite a difference between an Anaesthetic and an Operating Recovery Room. I suppose the Anaesthetic Recovery Room is about the greatest asset we have wangled out of Hospital Administrators in the last twenty years. I think it should commence activity the minute the patient leaves the operating room; the anaesthetist should take the patient to that recovery room and see that all his needs are taken care of, and the patient should remain in that room under trained supervision. It is necessary, I think, to have specially trained nurses there, as in any other part of the operating suite, and this room must be next to the operating suite. The patient must remain there, I feel, until he is conscious enough to respond to speech. His blood pressure must be stabilized, his respiration should be satisfactory, and there should be no signs of recurrent haemorrhage. Then, and only then, I think, should the patient be removed. Postoperative recovery rooms as I say are a different problem. The post-anaesthetic recovery room, as I understand it, is, in our experience, an eight-hour shift, so we cannot keep the patient to look after any surgical problems.

DR. SHEILA ANDERSON. I think that this is something every hospital should have. I agree with everything that Dr. Gain has said and will not add to it or detract from it. I think the patient should go into the recovery room immediately after

the operation, be under constant supervision until the anaesthetist is satisfied that there are no complications, and then returned to the ward. This may mean hours or even days.

Question 12

Dr. Leech. Here is another question that was recently handed to me.

> "In view of the disease retrolental fibroplasia, what place has oxygen in the treatment and handling of premature babies?"

Dr. Wyant, please.

Dr. Wyant. There is no doubt now, I believe, in most people's minds that retrolental fibroplasia is indeed in part caused by the high oxygen concentrations. It is the trend at the present time to try to nurse these babies without the aid of oxygen, and if oxygen is required to control the respiratory distress, we use it intermittently, when needed, and in low concentrations. I had occasion to discuss this with our obstetrician, and he feels definitely that any concentration over and above 30 per cent of oxygen in an incubator is harmful and should not be maintained for any length of time.

NEWS LETTER

Nova Scotia

Dr. André F. Pasquet, formerly Chief of Anaesthesia at the Montreal Neurological Institute, has joined the Department of Anaesthesia, Victoria General Hospital, and has been appointed Assistant Professor of Anaesthesia, Dalhousie University, Halifax.

°

The Post-Graduate Committee, Faculty of Medicine, Dalhousie University, will present a course in Anaesthesia, Feb. 27 to March 1, at the Victoria General Hospital, Halifax.

°

Dr. W. Muir, anaesthetic pioneer in Nova Scotia, is convalescing from surgery in Halifax.

°

Dr. A. S. Wenning has been appointed to the Department of Anaesthesia, Dalhousie University.

Quebec

Dr. Philip Bromage, formerly Consultant Anaesthetist to the Portsmouth Hospital Group, England, has taken up residence in Montreal, and with Dr. Cameron, formerly of St. Catharines, Ontario, has joined the Anaesthetic Staff of the Royal Victoria Hospital, Montreal.

°

Dr. Harold T. (Tony) Davenport, formerly of the Montreal General Hospital Staff, has been appointed head of the Anaesthetic Service, Children's Memorial Hospital, Montreal.

°

Dr. Wesley Bourne has been appointed an Honorary Fellow, and Dr. George Cousineau a Corresponding Fellow, of the Association of Anaesthetists of Great Britain and Ireland.

Ontario

Dr. Iain MacKay, Toronto, discussed anaesthetic problems of interest to practitioners before the Norfolk County Medical Society, Simcoe, in January.

°

Dr. Donald McIntyre, formerly of Vancouver, has joined the Anaesthetic Staff of the Grace Hospital, Toronto.

Manitoba

Dr. Virginia Apgar, New York City, addressed the Winnipeg Anaesthetic Society, January 23, 1956, on "Obstetrical Anaesthesia." The following day she addressed a combined meeting of anaesthetists, obstetricians, and paediatricians on "Infant Resuscitation."

Dr. Max Minuck spoke to the Winnipeg Anaesthetic Society, January 3, on "Obstetrical Anaesthesia" and Dr. Guenther Semulka discussed "Infant Resuscitation."

Dr. L. F. G. Cruickshank of Winnipeg has recently returned from Scotland, where he visited various medical centres.

Dr. Bernadette McGivern of Galway, Ireland, has joined the Anaesthetic Staff, Winnipeg General Hospital.

Dr. John Shields, formerly at the Children's Hospital, Winnipeg, will, after a trip to Great Britain, take up residence in St. Louis, Mo.

Dr. and Mrs. Chris Wolkenstein, Winnipeg, attended the New York Post-Graduate Assembly in December.

Recent appointments to the Children's Hospital, Winnipeg, are: Dr. J. I. Davies, Chief Anaesthetist; Dr. D. Huggins, Consultant Anaesthetist; Drs. Eshoo, Cruikshank, and McGaughney, Staff Anaesthetists.

Saskatchewan

Dr. Gordon Wyant has been busy this winter addressing three district medical societies on anaesthetic topics of interest to general practitioners.

The Saskatchewan Division of the C.A.S. held a dinner meeting in Saskatoon on November 27, 1955. The meeting was addressed by Dr. E. S. Haines of Saskatoon on the "Medical Treatment of Hypertension."

British Columbia

Recent additions to the Staff of the Vancouver General Hospital are Drs. M. H. Schultz, P. W. Hudson, and J. L. Oulton, the latter formerly on the staff of the Notre Dame Hospital, Vancouver.

Dr. Elsie Ritch has joined the staff of the Shaughnessey Veterans Hospital, Vancouver.

°

Dr. Fred Chee has been appointed Head of the Anaesthetic Department, St. Joseph's Hospital, Vancouver, and has been joined by Dr. Alice K. Roman, formerly on the staff of St. Paul's Hospital, Vancouver.

°

Dr. John C. Poole, of the staff of the Vancouver General Hospital, has been appointed Chairman of the Economics Committee of the B.C. Division of the Canadian Medical Association.

BOOK REVIEWS

LOCAL ANALGESIA: HEAD AND NECK. By Sir Robert Macintosh, d.m., and Mary Ostlere, m.b. E. & A. Livingstone Ltd.; Macmillan Company of Canada Ltd. Pp. 138. $4.70.

This is a short text limited to neuro-anatomy of the head and neck, of interest to the anaesthetist for block purposes. It is a detailed study of cranial and cervical nerves and their branches, arterial, nasal and oral cavities, which can be blocked for analgesic purposes. The anatomy is easily followed, even in detail, through the aid of excellent, simple diagrams, much more so than is usual in the standard anatomy texts. The latter third is confined to the technique and difficulties encountered in blocking these nerves and areas.

The book is recommended to all anaesthetists even if only for an exercise in anatomy. It is in the usual high standard of the Oxford centre.

S. L. V.

HYPOTHERMIC ANESTHESIA. By Robert W. Virtue, m.d., ph.d. Springfield, Ill.: Charles C. Thomas; Toronto: Ryerson Press. 1955. $2.75.

This small monograph on a subject of great current interest is published in the American Lecture Series. As Dr. Virtue himself points out in his Summary, it should not be considered a summary on hypothermic anaesthesia, but should be taken as an interim report on its status at the time of publication.

Considering the limited space (80 pages) Dr. Virtue has presented an amazingly complete review of the important literature on the subject, and has pointed up the many factors on which more knowledge is urgently required. His description of the Clinical Procedure is an outline of the procedure which he himself uses, and other anaesthetists experienced in this field will undoubtedly find room for disagreement in this chapter. The experience described here has been, as far as one can determine, limited to hypothermia in patients with cardiac disease or abnormalities of the great vessels.

Although knowledge in this field is accumulating so rapidly that it is almost impossible to bring to publication a monograph which will be contemporary in all respects, this volume may be recommended as an excellent review of the subject.

R. A. G.

SADDLE BLOCK ANAESTHESIA. By Ray T. Parmley. Springfield, Ill.: Charles C. Thomas; Toronto: Ryerson Press. $2.75.

This monograph is a worthy addition to the American Lecture Series. It is well produced and the technique, pros and cons of saddle block anaesthesia are fully described. Due emphasis is given to the dangers of spinal anaesthesia and

to the current medico-legal aversion to the method. With this in mind, one cannot help wondering as to the demand for a monograph on this subject at the present time.

The reviewer feels strongly that certain of the details of technique described are ill advised.

First, the method of sterilizing ampoules in fluid (regardless of its coloration, as recommended by Parmley) has surely been superseded by autoclaving? A propos of this, the practise of using Epinephrine in the local anaesthetic solution renders its satisfactory sterilization difficult.

Secondly, while the author may have had no cases of meningitis following the administration of spinal anaesthesia while ungowned, were litigation from such a complication to arise, the technique would be suspect; consequently, it is felt that the routine use of cap, masks, gloves AND GOWN should be taught to those intending to transgress the theca.

H. B. F.

MEETINGS

CANADIAN ANAESTHETISTS' SOCIETY, Annual Meeting, Mont Tremblant Lodge, Mont Tremblant, Quebec, June 18–19–20, 1956. See complete programme in this issue.

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Western Divisions, Canadian Anaesthetists' Society, Annual Meeting, Vancouver, B.C., April 5, 6, 7, 1956.

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Conference on Anesthesiology, New York Academy of Sciences, Barbizon-Plaza Hotel, New York City, May 18–19, 1956.

•

Canadian Medical Association, Annual Meeting, Quebec City, June 13–14–15, 1956.

CANADIAN ANAESTHETISTS' SOCIETY

ANNUAL MEETING, 1956

Programme—Monday, June 18

9.00 a.m.—Registration; Exhibits

2.00 p.m.—"Comparative Evaluation of Dolitrone in Human Volunteers"
Dr. Gordon Wyant, Saskatoon

2.30 p.m.—"Clinical Evaluation of Viadril"
Dr. R. A. Gordon, Toronto

3.00 p.m.—Break for viewing exhibits

3.30 p.m.—"Evaluation of a New Hibernizing Drug from Dibenzothiazine"
Dr. Gérard Mignault, Montreal

4.00 p.m.—"Ethyl-Vinyl Ether"
Dr. Doris Grosskreutz, Chapel Hill, North Carolina

8.00 p.m.—Council Meeting

Programme—Tuesday, June 19

9.00 a.m.—"An evaluation of Local and General Anaesthesia for Bronchoscopy"
Dr. H. B. F. Fairley, Toronto

9.30 a.m.—"Post-operative Care of Thoracic Surgical Patients"
Dr. James G. Robson, Montreal

10.00 a.m.—Break for viewing exhibits

10.30 a.m.—"Cortisone and Anaesthesia"
Professor Hans Selye, Montreal

11.00 a.m.—"Pulmonary Function Tests"
Dr. Fernand Grégoire, Montreal

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LUNCHEON

*

2.00 p.m.—"Experience with Hypothermia at Toronto General Hospital"
Dr. S. M. Campbell, Toronto

2.30 p.m.—"Anaesthetic Aspect of Thymectomy for Myaesthenia Gravis"
Dr. Jone Chang, Vancouver

3.00 p.m.—Break

3.30 p.m.—"The Use of Trifluoroethyl Vinyl Ether (Fluoromar) in Anaesthesia for Dentistry"
Dr. H. M. Slater, Montreal

4.00 p.m.—"General Anaesthesia for Ophthalmic Surgery"
Dr. John J. Davies, Winnipeg

Programme—Wednesday, June 20

9.00 a.m.—Round Table: "Anaesthesia for Caesarean Section"
Dr. Alan Noble, Montreal (Chairman)
Dr. Elizabeth Martin, Rochester, N.Y.
Dr. John J. Carroll, Vancouver
Dr. David Power, Montreal

10.00 a.m.—Break

10.30 a.m.—Annual General Meeting

°

LUNCHEON

°

2.00 p.m.—"The Clinical Use of Neraval"
Dr. Ralph Tovell, Hartford, Conn.

2.30 p.m.—"Artificial Heart-Lung Apparatus: Three Years' Experience on the Dog"
Dr. Jean-Louis Tremblay, Quebec City

3.00 p.m.—Break

3.30 p.m.—Round Table on Questions Submitted during the Meeting
Chairman—Dr. John Carroll, Vancouver

5.00 p.m.—Meeting of the 1956–1957 Council

7.00 p.m.—Cocktail Party

8.00 p.m.—Annual Dinner

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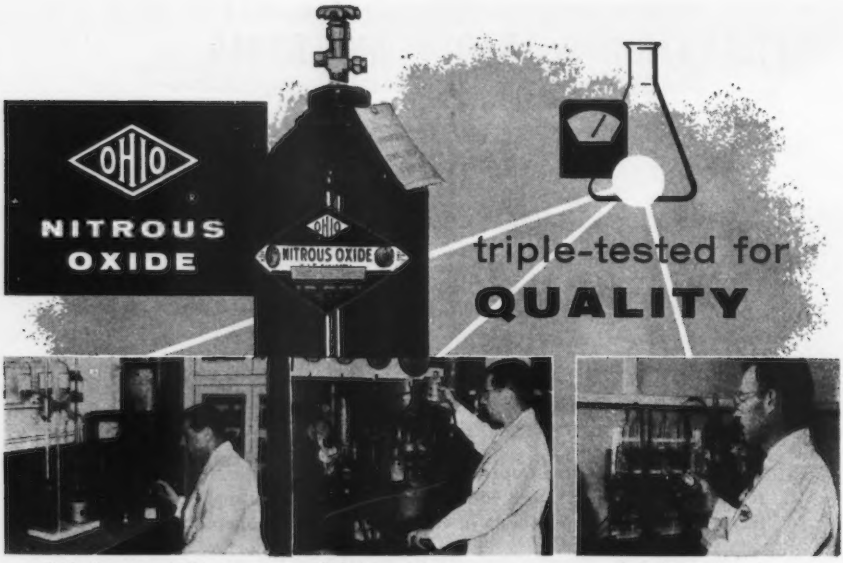

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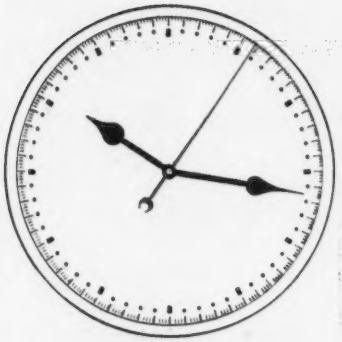

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